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CYBERNETICS, COMPUTERS AND AUTOMATION TECHNOLOGY

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AUTOMATED TEACHING SYSTEMS

Kiev UPRAVLYAYUSHCHIYE SISTEMY I MASHINY in Russian No 2, Mar/Apr 78 pp 12-20

/Article by Candidate of Technical Sciences Aleksey Mikhaylovich Dovgyallo, engineer Ol'ga Pavlovna Nebrat, Candidate of Technical Sciences Boris Alekseyevich Platonov, Institute of Cybernetics of the Ukrainian SSR Academy of Sciences (Kiev): "Computerized Learning: The Current Status and Prospects"/

/Text/ Directions of the Use of Computers in the Educational System. The current rate of development of science and technology is making new demands on the system of the education and training of personnel. This development of organizational structures in the educational system is taking place along with the development of new methods in teaching and the control of the educational process (programmed instruction, standardized testing, teaching machines, the scientific organization of labor at the educational institution, the use of methods of mathematical statistics, business games, mathematical models and so forth). A logical consequence of the use of these methods is the use of computers in the educational process, which is also being promoted by the development of computer technology itself: the simplification of the interaction of man and computer, the reduction of the cost of computer time, the creation of systems of collective use, as well as the increase of the computer pool.

The work on the use of computers in the educational system is being developed in four rather independent directions:

1. The development and use of automated teaching systems (ATS's).

2. The creation of service dialog means or systems, which are designed for assisting the user in solving educational or any other problems on computers. Belonging here are: systems which implement the techiques of sampling from a "menu" /1/; teaching-programming systems /2-4/; systems for the dialog construction of algorithms and the simultaneous solution of problems /5-7/; various models which imitate real situations, and so forth.

3. The creation of automated control systems of educational institutions at various levels.

4. The automation of research and development in the sphere of education.

It is necessary to indicate another circumstance which promotes the development of work in the area of teaching using computers. The needs of the increase of the efficiency of computer technology and systems of automated data processing require the creation in each computer of a "teaching and assistance environment" /2, 8/ which should surround its user. It is natural that the availability of such means would open the way both for the "self-introduction" of computers in the national economy and for the constant increase of the knowledge of the users of the potentials of computers and their development.

In the article a survey and analysis are made of the works devoted to the first two of the indicated directions. The survey, in principle, is of a selective nature, since the greatest attention of the authors was attracted by the development connected with the training of the users of computers. There is given a "geography" of the most typical automated teaching systems which have been created abroad and in our country during the past decade. An evaluation of some of them is given, an example of the introduction of computers at educational institutions is cited. The economic aspects of the use of computers in ATS's are analyzed. A list of the problems which are to be solved in the immediate future is cited.

Automated Teaching Systems. In the past decade abroad (primarily in the United States) in the development of ATS's the path has been covered from partial realizations on small and intermediate computers with 2-3 learners to developed systems of collective use and networks of computers for educational purposes. The most typical representative of the later is the PLATO-IV system of CDC /9, 10/, which operates on the basis of the CYBERNET network consisting of 15 large computers and which had within it in September 1975 more than 900 terminals--plasma graphic displays which are used for educational purposes.

Computer equipment production companies--above all IBM, Hewlett Packard, DEC, Syemens, as well as universities--primarily are engaged in the development of means, methods, devices and programs for ATS's. IBM has also developed the IBM/1500 computer series, which is designed especially for ATS's /11, 12/. True, subsequently this series was not introduced in extensive practice, and the company shifted to the development of Coursewriter (versions I, II and III). The most up-to-date version of Coursewriter at present is version 3 /13/. More than 50 teaching courses on various subjects have been prepared for it. On the basis of Coursewriter IBM developed ITS (Interactive Training System) /14/ for the training of the users of the IMS data bank /15/ and the system of control of the CICS data bases /16/. A significant distinction of ITS from Coursewriter is the fact that in ITS the programs obtained in the process of instruction can be automatically transferred to an account.

Hewlett Packard and DEC have taken the route of creating ATS's on the basis of their own systems of collective use (see, for example, HP 2000 /17/).

Syemens has developed LIDIA for the Syemens-4004 /18/.

In England ATS's have been set up, in particular, at the University of London and Cambridge University on the basis of a set of Elliott and PDP-11 computers /19/, as well as ATLASE computers /19/.

In France, at the Institute of Applied Mathematics of Grenoble University, MAGISTER has been developed for the IBM/360 /20/.

A wide variety of terminals are also being produced, among which in addition to the usual means of connection with computers (teleprinters, displays) there can be included audiovisual means of instruction (slide and movie projectors, screens for the display of moving drawings, sound equipment and others).

There have been developed and implemented problem-oriented languages which permit teachers, who do not have special training in the area of programming and computer equipment, to write in a language, which is quite simple and at the same time powerful, teaching and testing programs which implement the main ideas of programmed instruction /21/, the standardized and test verification of knowledge.

Considerable libraries of teaching and testing programs have been written in these languages, as well as in programming languages (FORTRAN, APL, BASIC and others). True, the majority of these programs "are of a clearly drill-and-practice nature on selected narrow topics" /22/.

Interesting data on the use of specialized and universal languages for writing teaching programs in the United States and Canada are cited in work /23/. Of the entire diversity of languages being used the most programs are written in Coursewriter, however most often programs written in FORTRAN were used during instruction. The author of this work believes that the obtained results characterize the insufficient prevalence of specialized languages as compared with universal languages.

The experience of the schools of Montgomery County (Maryland) can serve as an example of the extent of the introduction of ATS's at educational institutions of the United States. At three schools of the county 31 terminals were installed, which are served by an IBM/1500 regional educational computer. There are about 40 educational courses in this system on geometry, arithmetic, algebra, physics, geography, the principles of computer technology and others. The majority of the courses were written by the teachers of these schools, who in order to increase their skills learned themselves on ATS's. The training took place under the guidance of ATS specialists. The programming languages of the educational courses were Coursewriter and APL. For the indicated 40 courses in 1973 1,400 pupils used

more than 5,500 hours (that is, on the average per pupil there were approximately 4 hours of work at the terminal). At the same time 31 teachers were taught the basis of ATS using computers.

A considerable share of the ATS's created in our country were connected with the training of the users of computers. They were mainly developed for computers of the Minsk, BESM and Dnepr series. Among them let us name the following:

the ATS for the teaching of the language ALGOL-60, which was created at the Riga Polytechnical Institute /24/;

the ATS for the teaching of assembly language INZHENER, which was created at the Belorussian University /25/;

the PEDAGOG ATS for the teaching of COBOL, which was developed jointly by the Institute of Cybernetics of the Ukrainian SSR Academy of Sciences and the Ukrainian SSR Institute of Psychology /26, 27/;

the KONTROL'-BESM ATS for the teaching of FORTRAN, which was created at the Institute of Cybernetics of the Ukrainian SSR Academy of Sciences /28/;

the ATS for the teaching of the arithmetical principles of computers /29/;

the DIALOG-BESM-6 ATS for the teaching of a specialized programming language, which was created at the Computer Center of the USSR Academy of Sciences /30/.

ATS's, which are not designed specifically for the training of computer users, are, for example:

the KODIAL-SOAVTOR ATS, which was developed for the Minsk-32 computer /31/ jointly by the Institute of Cybernetics of the Ukrainian SSR Academy of Sciences and the Riga Polytechnical Institute. At present a new version of the KODIAL-SOAVTOR ATS is being created for the Unified Computer System with the participation of Simferopol' State University;

the ATS for the teaching of differentiation and integration /32/;

the SPOK (system of programming and support of maintenance and teaching courses) ATS, which was developed for the operational system DOS YeS at the Institute of Cybernetics of the Ukrainian SSR Academy of Sciences /33/.

Additional data on the ATS's being developed in the country can be found in work /34/.

It should be indicated that the work of those being taught with the ATS can proceed in two forms:

in a dialog mode. In foreign literature such ATS's are called CAI (Computer Assisted Instruction) or CAL (Computer Assisted Learning), that is, "instruction using computers";

in the package mode. The systems are called CMI (Computer Managed Instruction), that is, "instruction directed by computer." Moreover, considerably more dialog ATS's have been developed in our country than abroad.

In rough outline the process of instruction using ATS's can be represented in the following manner. The person being instructed is given the educational material and one or several (in the case when a test of the mastery of a section of the educational material is being made) test questions. The person being instructed answers the questions, the ATS checks the answers and depending on the degree of their correctness gives the person being instructed the next part of the educational material, auxiliary material or recommendations which help to correctly solve the posed problem.

A record of the dialog of a person being instructed with the PEDAGOG ATS is cited, for example, in work /6/.

In evaluating the gained experience of using ATS's, it is necessary to note its positive aspects which are expressed both in a reduction of the total time of instruction and in the increase of its quality. The increase of quality is ensured by the following factors:

there is the possibility of the operational and documentary monitoring and observance of the activity of those being instructed, which permits the teacher or teaching program to make more adequate didactic decisions, to give assistance to laggers in due time and so forth;

the conditions are created for independent studies of the person being instructed with the possibility of a choice of the individual rate of instruction and the level of assistance;

the calculating and modeling potentials of the computer are used for educational purposes.

The development of ATS's at present involves the solution of three problems. These problems are:

1) the more complete utilization of the computer as a means of solving the problems (including educational) facing those being instructed;

2) the creation of sufficiently large educational courses which make it possible to entrust the computer with a more significant portion of the instructional work with those being instructed;

3) the further extension of individualization and assistance in instruction both at the request of the person being instructed and automatically--on the basis of the analysis of his model.

The solution of the first problem should above all be attached to the instruction of users by using a computer. Here the computer acts simultaneously as both a means of instruction and the object of stucy, which makes it possible, in particular, when teaching programming to carry out the developed syntactic and semantic checking of the answers of the person being instructed with an indication of the necessary actions on the localization and elimination of errors, as well as on the interpretation of the messages of the person being instructed (including incorrect answers for the purpose of showing the consequences of the errors made).

The indicated possibilities were realized in the PEDAGOG ATS, as well as in the American systems AID /35/ and TEACH /36/, where the teaching program interacted with the corresponding system of programming.

The second problem, which is connected with the realization on computer of a sufficient amount of educational material--entire courses, large sections of an academic discipline (it is possible to say "of large instructional programs"), which make it possible to entrust the computer with a more significant portion of the work with those being instructed--for the present is farm from its solution. This is connected with the fact that at present the "set of tools" for the creation of large instructional programs is only being formed. But the languages, which have been realized in modern ATS's, of the writing of instructional programs, for example, Coursewriter, TUTOR (PLATO), PILOT (Hewlett Packard) and YAOK (SPOK), due to the limitedness of means do not always create sufficiently "intellectual" large instructional programs.*

Moreover, whereas for small programs a group of developers--the instructors themselves--has already been formed, for large programs the collectives of developers are only being formed. From foreign experience we can cite the work being carried out by the MITRE Corporation /10/ on the TICCIT project, as well as the work of DEC.

A few words concerning the solution of the third problem. A well-known American specialist in the field of CAI, (P. Suppes), said the following /37/: "In essence, the fundamental difficulties standing in the way of instruction using computers are not of a technical, but of a pedagogical nature: it is not known what the methods of individualized instruction should be and how the educational program designed not for a group, but for the individual student should be formulated.... And so far we do not have any truly distinct idea of what degree of individualization it is possible to take instruction to. Obviously, some time will be needed before this problem will be able to find a sufficiently detailed substantiation." Thus, the roots of the solution of this problem lie in the area of pedagogy and psychology.

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*As the cited observations show, there are indeed different demands on the level of "intellect" of small and large instructional programs. In small programs the novelty and narrow direction of the dialog with the computer ensure the efficient work of the person being instructed even with a very simple instructional program.

Instruction and Service in the Process of Solving Problems Using Computers. No matter what area of human activity we take, it can always be represented as the process of solving some problems or others /38/. The processes of instruction and training can also be regarded as the process of solving educational problems, during which the person being instructed forms knowledge, ability and skills, that is, the means necessary for the solution of problems in the field of the future occupational activity of the person being instructed.

The ATS's examined above realize, as a rule, the same overall strategy* of instruction: initially there form in the people being instructed the means of solving problems of a specific class, and then they begin to use these means for the solution of their own problems. For example, in the PEDAGOG ATS the person being instructed after instruction using the COBOL system sets out to solve his own problems on the computer, that is, to program in COBOL.

The increasing need to solve on computers the problems of users, who do not have vocational training in the area of programming and are specialists in other fields, made it necessary to look in a new way at the process of training users and served as the impetus for the development at the Institute of Cybernetics of the Ukrainian SSR Academy of Sciences** new methods of serving users who implement the strategy "from the problems to the means of their solution." This strategy should ensure the computer controlled mastery by the user (person being instructed) of the computer means (for example, programming languages not known to him) in the very process of solving on the computer problems from the field of his occupational activity.

The idea at the basis of the developed methods was first used for the instruction of users and assistance when working on a computer in operational modes.*** The number of such systems developed so far is quite extensive. Among them there are both the "conversational" implementation of the traditional programming languages (FORTRAN, ALGOL, PL/1) and systems which implement special languages of operational interaction (BASIC, JOSS, APL/360). Instructional and training programs are beginning to be introduced more and more often into the libraries of these systems.

The command HELP is included at present in a number of systems of operational programming, which are oriented toward users with different skills, including the new user. MERITSS**** of CDC has the standard possibilities on this level.

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*Henceforth we will call this instructional strategy the strategy "from the means of solution to the problems."

**In cooperation with the Kiev Polytechnical Institute, the Belorussian State University and the Ukrainian SSR Institute of Psychology.

***Operational modes are understood as in work /2/.

****MERITSS--Minnesota Educational Regional Interactive Time Sharing System.

The instruction HELP, as a rule, in MERITSS is used in those instances when the user is uncertain of the knowledge of the formats of commands in the language of the instructions or of the peculiarities of their use. Upon instruction a description of all the commands or the necessary command is given. Similar possibilities as applied to the means of programming languages already exist in the systems AMTRAN /40/, APL/360 /41/ and AID /35/. The last system has developed means of instruction--a CAI program, which embraces all the means of AID. In the APL/360 system these are the instructions TEACH and DESCRIBE.

In recent years in some systems of operational interaction (for example, ASU's /automated control systems/, airline ticket reservation systems) there has become more and more widespread the so-called technique of the "menu," that is, the technique of the computer-initiated informing of the user about the subject matter of the data base, the types of permissible inquiries and others.

The indicated means substantially facilitate for the user the solution of his problems on the computer, however, they usually help in solving a narrow class of problems or even one problem. Moreover, the nature of their assistance is static and in a number of cases requires special training of the user.

A new step in the creation of systems of service of the nonprofessional users was the realization of the strategy "from the problems to the means of their solution" in the so-called "prescribing and directing systems" (PNS's) /2, 6/, which provide an operation-by-operation order or instruction of what the user needs to do and how in order to perform some operation in the process of solving the problem. PNS's (like TEACH-HELP modes) are being designed more and more often for the solution not only of educational, but also of simple practical problems /2, 6/. Unlike these modes, in which the computers "take care of" the user, as a rule, occasionally, more precisely upon his inquiry, in the PNS's all the activity of an unskilled user is placed under the control of the computer.

As to the users of computers in contrast to ATS's, which provide the training of users for the independent performance of actions or specific operations in the process of solving a problem, the PNS ensures the joint performance with the user of actions of the process of solving a problem of a specific class.

In principle, it is possible to bring a specific type of PNS in line with each of the actions on the solution of a problem on a computer /2, 21/. In particular, it is possible to single out a PNS for control by the users during the search and input of data and/or a program in the "menu" proposed by the computer; during programming in a language unknown to the user; in the construction of algorithms and in the specification of the statement of the problem.

In 1971-1974 there were developed and implemented the experimental PNS's DIPROFOR /3, 4/, which controls the work of a user who is not acquainted with FORTRAN when he writes a program in this language, and DISKAOD /5, 6/, which guides the user in the specification of the statement of the problem and the construction of the algorithm of its solution in the language YAOD which he does not know /42/. The overall organization of these systems and the results of their testing have been covered quite extensively on the pages of the journal UPRAVLYAYUSHCHIYE SISTEMY I MASHINY /3, 6, 8/, therefore here we will not dwell on them in detail. Let us point out only that at present the Institute of Cybernetics of the Ukrainian SSR Academy of Sciences jointly with Kishinev State University is carrying out the development of a system similar to DIPROFOR within the SPOK ATS.

Economic Aspects of the Use of Computers for Instruction. Until recently one of the factors slowing down the extensive introduction of computed-assisted instruction was the lack of data on the economic efficiency of computers under the conditions of the increase of the cost of instruction as compared with traditional methods.

The overall cost C of the outlays per hour of service of the user of an ATS is formed from the cost of a session of connection to a computer of collective use--C_{CH}; the cost of a terminal subscription--C_T; the cost of the instructional course--C_{Kypca}; the cost of the development of the ATS, in which the course functions--C_{pa3p}. If the ATS is developed for one course, the C_{Kypca} is included in the C_{pa3p}.

/The cost of a session of connection/ /in italics/ is calculated as the ratio of the cost of an hour of operation of the resources of the computer to the number of subscribers of the system. With the maximum load of a SPOK system, for example, which is capable of serving 256 users and a cost of an hour of computer time of the Unified Computer System of 80 rubles, $C_{CH} \approx 0.3$ rubles/hour.

/The cost of a terminal subscription/ /in italics/ is calculated according to the formula:

$$C_T = \frac{\text{Ц}_T}{t_1 t_2},$$

where t_1 is the number of hours of operation of the terminal during the year; t_2 is the term of serviceability of the terminal in years; Ц_T is the price of the terminal.

The price, for example, of the package of a YeS-7906 with four displays is 31,000 rubles. With t_1 = 2,000 hours/year (or 8 hours a day) and t_2 = 10 years, $C_T \approx 0.4$ rubles/hour.

/The cost of a course/ takes into account the cost of the labor expenditures on the preparation, programming and debugging of the program of an

instructional course for one hour of work of the use and is found by the formula:

$$C_{\text{курса}} = \frac{T_1 Ц_1 + Ц_2 \kappa_1 T_1}{t_3 k_2},$$

where T_1 is the number of hours spent by the instructor (programmer) on the preparation and programming of one hour of the lesson which is being implemented using the computer;

$Ц_1$ is the cost of one hour of work of the instructor (programmer);

$Ц_2$ is the adjusted cost of an hour of computer time;

k_1 is the coefficient which shows what portion of the time T_1 the instructor (programmer) uses on the computer;

t_3 is the term of "amortization" of the instructional course (in years);

k_2 is the number of persons being instructed who have used this course during the time t_3.

According to the data /36/ T_1 is 100-200 hours in the preparation of a hour-long course (for the calculation let us take 200). $Ц_1$ can be calculated from the average wage of a programmer of 130 rubles and 35 percent of the overhead, that is, $Ц_1$ = 1 ruble. For the DOS YeS with the work in three sections, and in the section taken up by the ATS, as, for example, in SPOK, where the simultaneous work of four users is provided for, $Ц_2$ = 6.7 rubles/hour (80 rubles : 12). According to the data of work /36/ k_1 is 60 percent of the total time of the preparation of the course. Thus, the average cost of the programming of an hour-long course in an ATS like SPOK for the Unified Computer System is about 1,000 rubles. The calculated amount agrees with American data. For example, according to the data of Boeing /36/ this amount is $1,000; according to the data of CDC /9/ it is from $512 to $1,763. If we take the term of amortization of a course to be t_3 = 4 years, as well as take into account that during this time the course is used (during two semesters) by 100 students each year, then $C_{\text{курса}}$ = 1.25 rubles/hour. The debugging of the course during the period of use, of course, increases its cost.

At any rate the relative and absolute expenditures on the preparation of a course for the present are very great. The attempt to reduce these expenditures led to the idea of creating special systems which permit the user, who does not have special programmer training, to write his own courses in the dialog mode with the system in a language close to natural language. The essence of this idea reduces to the creation of a special program which is used as the dialog preprocessor of the interpreter of the ATS. At present we know of two realizations of such preprocessors--SCHOLAR-TEACH-II /18/ and SOAVTOR /31/.

A check of the SCHOLAR-TEACH-II system yielded the following results: the time spent on the preparation of one hour of a lesson is decreased to 19 hours (as against 100 hours before the use of the system), that is, the expenditures can be reduced to approximately one-fifth.

/The cost of the development of an instructional system/ /in italics/:

$$C_{\text{разр}} = \frac{S}{t_4 k_3 n},$$

where S is the total amount of the expenditures; t_4 is the term of amortization of the system (in years); k_3 is the average number of people being instructed, who use the system during the time t_4 on one computer; n is the number of computers for which this system is issued.

For second-generation instructional systems, which have been developed in our country at present, $C_{\text{разр}}$ can be calculated in the following manner: S = 250,000 rubles (on the basis of the experience of developing the SPOK ATS); t_4 = 10 years; $k_3 = n_1 t_3 n_2 \text{п}$, where

n_1 is the number of courses which are served by the given system (let us take $n_1 = 10$);

t_3 is the term of "amortization" of one course, which is equal to four years, as in the calculation of $C_{\text{курса}}$;

n_2 is the number of students who use one course during one year (let us take $n_2 = 200$);

п is the duration of one course; according to the latest data /9/ it is 10-15 hours.

Let us take n = 1. Given the assigned values, $C_{\text{разр}} \approx 0.3$ rubles. It is natural that the increase of the number of computers for which the system is used, the increase of the number of courses in the ATS, as well as the increase of the number of those being instructed sharply reduce the $C_{\text{разр}}$.

Thus, under all the enumerated conditions which, in our opinion, reflect the present day of development of ATS's for computers of collective use in the USSR, the maximum cost of one hour of work of a person being instructed with an ATS is

$$C_{max} = C_{\text{сн}} + C_{\text{терм}} + C_{\text{курса}} + C_{\text{разр}} = 0.3 + 0.4 + 1.25 + 0.3 = 2.25 \text{ rubles/hour.}$$

With the creation of service for the instructor (such as the preprocessors SOAVTOR or SCHOLAR-TEACH-II), which reduces $C_{\text{курса}}$ to 0.2-0.3 rubles/hour and the edition of the ATS for 3-4 computers (here $C_{\text{разр}}$ can be ignored):

$$C = 0.3 + 0.4 + 0.3 = 1 \text{ ruble/hour.}$$

Consequently, the cost of one hour of servicing of a person being instructed in an ATS of "average capacity" is already now quite acceptable from the point of view of necessary expenditures.

A small direct economic impact from the introduction of general-purpose ATS's at secondary schools and VUZ's can be obtained by the reduction of the instruction time,* as well as by the facilitation of the work of instructors under the conditions of automated instruction and testing of knowledge. The indirect economic impact at the expense of the subsequent more productive work of those being instructed, which can be promoted by the increase of the quality of their training owing to ATS's, can be much more significant. In the area of vocational training, for example, in the teaching of programming, the increase of the quality of instruction frequently leads to an increase of the productivity of the programmer by 1.5-2 times [6], which leads to a direct economic impact.

Conclusion. With each year computer-assisted instruction is assuming a more and more specialized and practical importance. The interest in ATS's is determined both by the overall needs of the modernization of the educational system in connection with the second scientific and technical revolution and by the urgent need for the "self-introduction" of computers in the national economy and for the steady increase of the level of training of the users of the most different categories.

In our country there has been developed and introduced in the Unified Computer system a quite effective "set of tools" (SPOK, KODIAL-SOAVTOR and others) for the creation of ATS's, which is not inferior to the best foreign models (Coursewriter III, MAGISTER and others). Therefore right now it is necessary to direct the main efforts at the creation of automated instructional courses within the standard ATS, as well as methods of their use in the real educational process at VUZ's and educational centers for training and the improvement of skills, at computer centers, schools and tekhnikums.

Under the conditions of insufficient financing the standardization of educational and program "items," as well as coordination and cooperation among the main developers when creating the basic libraries and "banks" of automated instructional courses are assuming primary importance. The need has arisen for the development and approval of an all-union program for 7-8 years on the problem "The Development and Introduction of Instructional, Training and Service Dialog Systems on the Basis of Computers," which is aimed at the automation of the system of the education and training of personnel.

The coordination of the work on ATS's for the purpose of increasing the level of the "intellect" of instructional and dialog systems, as well as

*As a rule, by 1.5-2 times as compared with instruction without ATS's [6, 9].

for the purpose of creating the principles and means of the generation of automated instructional courses is assuming primarily importance.

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STANDARD DATA PROCESSING MEANS IN COBOL AND PL-1

Kiev UPRAVLYAYUSHCHIYE SISTEMY I MASHINY in Russian No 2, Mar/Apr 78 pp 59-62

/Article by Candidate of Physical and Mathematical Sciences Lyudmila Petrovna Babenko, Institute of Cybernetics of the Ukrainian SSR Academy of Sciences (Kiev): "A Comparison of the Standard Data Processing Means in COBOL and PL-1"/

/Text/ The selection of the appropriate programming language during the designing of automatic data processing systems, particularly automated control systems, is of great importance and in many respects predetermines the timeliness of the completion of the development, its viability, transferrability to other computers and its overall cost. At present COBOL and PL-1 are the main competitors for the role of the programming language of problems of data processing. The functional means of these languages, which are oriented toward data processing, partially coincide and partially have fundamental or syntactic distinctions, which complicates the analysis of the applicability of each of the languages to one group or another of problems. When he encounters a problem of the choice of the programming language, the developer is practically deprived of specific objective recommendations and might be guided only by the opinion which has become widespread recently among a portion of our programmers, that PL-1 is the most powerful of the languages and it is necessary to orient toward it. At the same time another group of programmers relies on foreign experience, which indisputably shows the preferableness of COBOL for problems of data processing.

In this work an effort is made to obtain objective characterizations of the applicability of the languages in question for various aspects of data processing.

The utilized approach to the comparison of programming languages* is based on the distinction of the conceptual units which describe an area of the

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*L. P. Babenko, V. D. Rogach, Ye. L. Yushchenko, "On the Question of the Comparison and Classification of Programming Languages," KIBERNETIKA, No 2, 1975, pp 84-90.

application (in this case the field of data processing) and reflects the main functions used in it of the processing of information. Moreover, the model of our knowledge of the corresponding area is expressed by a set of concepts and the established relations between them, which is called the thesaurus of the area of application. When examining the possible candidates for the role of the appropriate programming language for some group of problems it is necessary to construct a reflection of the elements of the thesaurus of the corresponding area of application on the descriptive means of each of the candidate languages in question and to compare the measure of coverage by the language means of the main concepts of application and the convenience of their expression. Thus, there is obtained an objective picture of the applicability of each of the candidate languages to the main aspects of the processing of data of a specific application, on the basis of which the appropriate choice of a language can be made.

The subject of examination of this article is the field of automatic data processing, to which at present belongs the majority of the problems being solved on computers throughout the world. The following were selected as the main aspects of examination of this field: the data structures used; input-output means; means of processing strings; means of processing tables; means of reordering information; the formulation of reporting documents of complicated forms.

For five of the above-listed aspects there has been construction a diagram of the concepts encompassing it (see the diagrams), which are ordered by the relation "input-connect," and the reflection of the nodes of this diagram on the corresponding means of the languages in question is analyzed. The reflection is examined on a problem-oriented level, at which the language means realize the set function of data processing as a standard algorithm, and not as a sequence of the procedural steps programmed by the user of the realization of this algorithm. It should be noted that in such universal programming languages as COBOL and PL-1, the majority of functions of data processing can be realized on the procedural level, but we will take into account that the reflection of some function on the language means is specified only when a set of operators and phases of the description, which realize the corresponding function, clearly functions in the specifications of the language.

The list of language candidates in question is limited to COBOL and PL-1, although ALGOL, FORTRAN and RPG are also on the list of languages which are supplied serially with domestic computers. However, ALGOL and FORTRAN are not designed for the problems of data processing and do not contain the majority of means in question. As to RPG, it is a specialized language which embraces only very limited aspects of data processing, owing to which it cannot claim the role of the base programming language in the area in question. At the same time it is expedient to examine independently a number of versions of each of the candidates, namely:

two versions of PL-1, which are realized in the OS YeS EVM and DOS YeS EVM operational systems;

two versions of COBOL, the first of which is realized at present in the OS YeS EVM and DOS YeS EVM operational systems, while the second is represented by the State Standard "COBOL Programming Language" and is being prepared for realization.

Means of Determining the Structure of the Data in COBOL and PL-1. By these means we will understand the methods of determining the notion of the user about the data. The set of data structures is characterized by the permissible types of structures and the rules of the construction of some types of structures from others.

Each type of structure has a set of features which distinguish it from the other types. A comparative analysis of the means of determining the structure of the data in COBOL and PL-1 was made in the above-indicated work. Let us cited the brief results of this analysis.

The examined versions of PL-1 and COBOL have the same permissible types of structures, namely: an element, a group, an entry and a file. The rules of their composition also coincide. The diagrams of the features of each of the permissible types of structures and their reflection on the descriptive means of COBOL and PL-1 make it possible to come to the conclusions that the possibilities of PL-1 and COBOL for the representation of the data structures coincide; the differences reduce to the following:

a) the representation of the strings: PL-1 permits strings of bits which do not exist in COBOL; in turn, COBOL makes it possible, unlike PL-1, to distinguish the sequence of letters (the letter string) from the sequence of any type-characters (the letter-number string);

b) special categories of data: the special processing of sterling currency units is provided for in PL-1; in COBOL provision is made for the special category of data INDEX, which is designed for the implementation of accelerated access to the data;

c) special coding: in COBOL means are used for the coding of some data with the retention here of the possibility of access to them according to their mnemonic significance when setting the condition; in PL-1 such a possibility is lacking;

d) the ordering of repeating data: in COBOL, unlike PL-1, there is the possibility of setting the order of the repeating data, which makes it possible to use accelerated methods of retrieval during their processing.

Comparison of Input-Output Means. The functional possibilities of the means of the organization of access to the data in the external carriers of the storage, which are traditionally called the input-output means, are

represented by diagram 1. The following are singled out as the main concepts which characterize the given aspect of data processing:

the structure of the storage of data in external carriers. The languages in question use a single type of structure of storage, namely the file which consists of entries;

the unit of exchange of data between the working field of the program and the external carriers of the storage. The entry is usually the logical unit for the languages in question. For small amounts of input-output the unit of exchange may be the elementary datum or a group of data (the exchange of data by a flow in PL-1, the operators RECEIVE-OUTPUT in COBOL);

the organization of the file, that is, the structure of the file, which is established during its creation and influences the possible methods of access to the entries of the file. In the languages in question provision is made for means of the sequential, index-sequential, relative and direct organization of the files;

the method of access to the file. In the languages in question the means of sequential and direct access and the dynamic change of the methods of access in the process of processing the file by some problem are provided;

standard input-output operators. In both COBOL and PL-1 the operators of the preparation of the file for operation OPEN and the completion of the work with this file CLOSE are obligatory, the operators of reading from the file, the writing in of the entry and the updating of the file are provided for.

An examination of the diagram makes it possible to draw the conclusions that the functional possibilities of the input-output means in COBOL and PL-1 basically coincide both from the point of view of the storage structures being used and from the point of view of the permissible methods of access and the possible operators. The differences reduce to the following possibilities which exist in COBOL and are absent in PL-1:

during work with sequentially organized devices the user has the opportunity to control by means of program the exchange of the volume of the file or the rewinding of the tape;

at the level of description of the file it is established, of which entries it consists; this is of great importance for the documentation of programs;

the coding of the type-characters which are permissible for sequential files in the external carriers can be distinguished from the coding of the internal set of type-characters, which is used for the given computer, and can be determined by the user, moreover, automatic recoding is ensured in the process of input-output.

Means of Processing Strings. By strings we will understand the data, the values of which are represented by sequences of contiguous type-characters or sequences of bits. It should be immediately pointed out that the type of data "a string of bits" is not provided for in COBOL, while in PL-1 this type of data is specified. However, the manipulation of strings of bits is characteristic more of computer-oriented programming languages than problem-oriented languages and is not a logical function of data processing, while the manipulation of strings of type-characters or textual variables plays an important role in it, since the majority of automated data processing systems operate with documents containing texts. Subsequently in this section by the term "string" there will be understood a string of type-characters and the peculiarities of processing only for strings of type-characters will be discussed.

Diagram 2 of the concepts of the means of processing strings is presented below. Let us explain some points of the diagram.

The permissible attributes of the strings in the languages in question have much in common. Both languages permit strings of variable length, but require the setting of the maximum permissible length of the string. In COBOL this maximum length should be clearly specified in the section of the data, while in PL-1 it can be determined dynamically at the moment of the input into the block or the arrangement of the based variable of the type of string, which can substantially reduce the expenditures of the storage for some problems.

The examined set of operations on strings reduced to the following operations:

the isolation of the substring or the decomposition of the string into its component substrings;

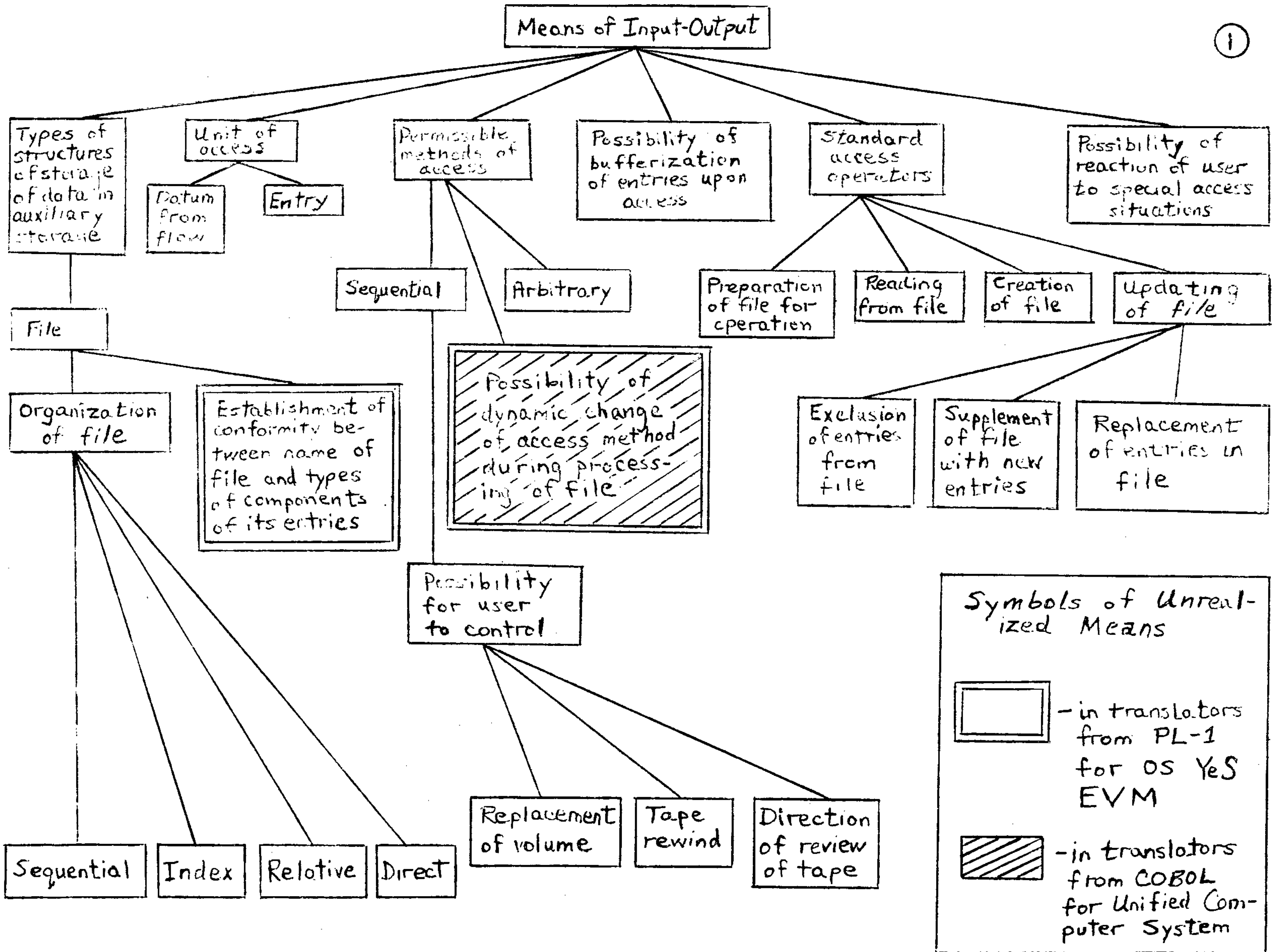
the assignment of a value to the substring;

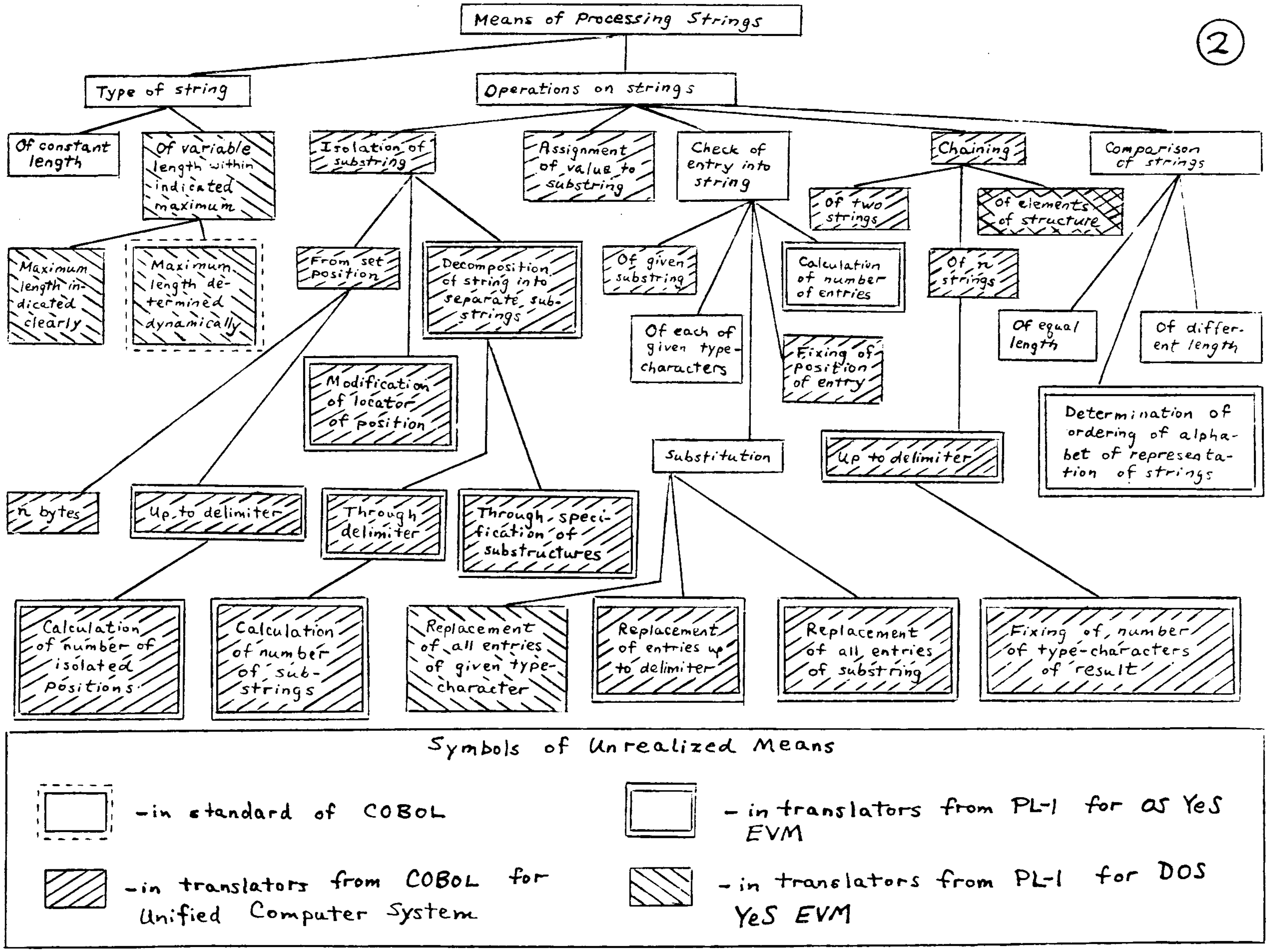
the verification of the fact that the string will contain some substring equal to the set sequence of type-characters (the verification of the entry of the substring);

chaining (or concatenation) of several strings;

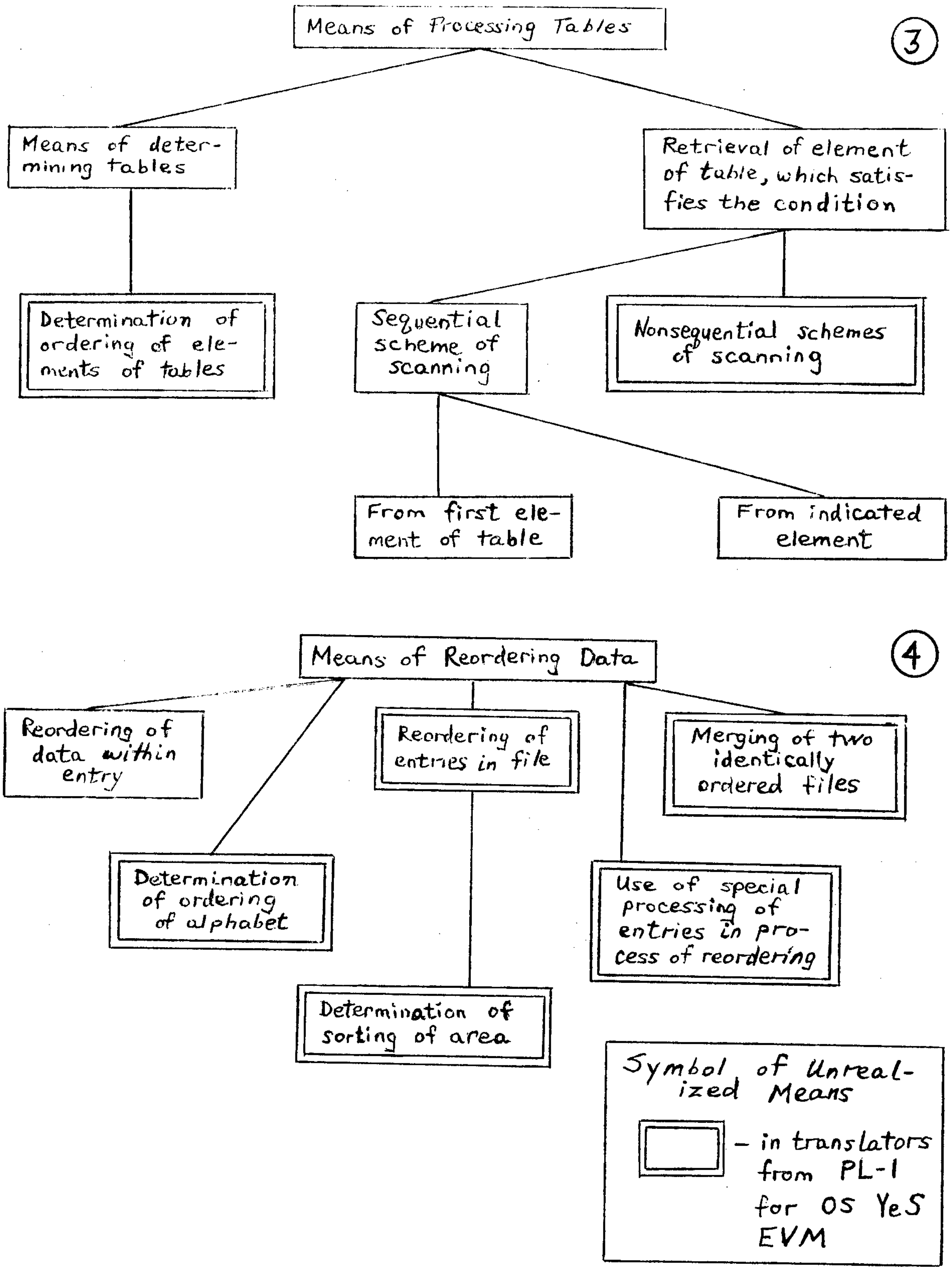
comparison of strings.

Let us note right off that both the complete version of PL-1 for the OS YeS EVM and the standard of COBOL contain means of one execution or another of each of the above-listed operations, while in the execution of COBOL in question for the Unified Computer System there are only operations of the comparison of strings and type-character substitution (that is, the replacement in the value of some type-characters by others), while in the version of PL-1 for the DOS YeS EVM the means of processing strings have a number of additional limitations, which are outlined in the diagram.

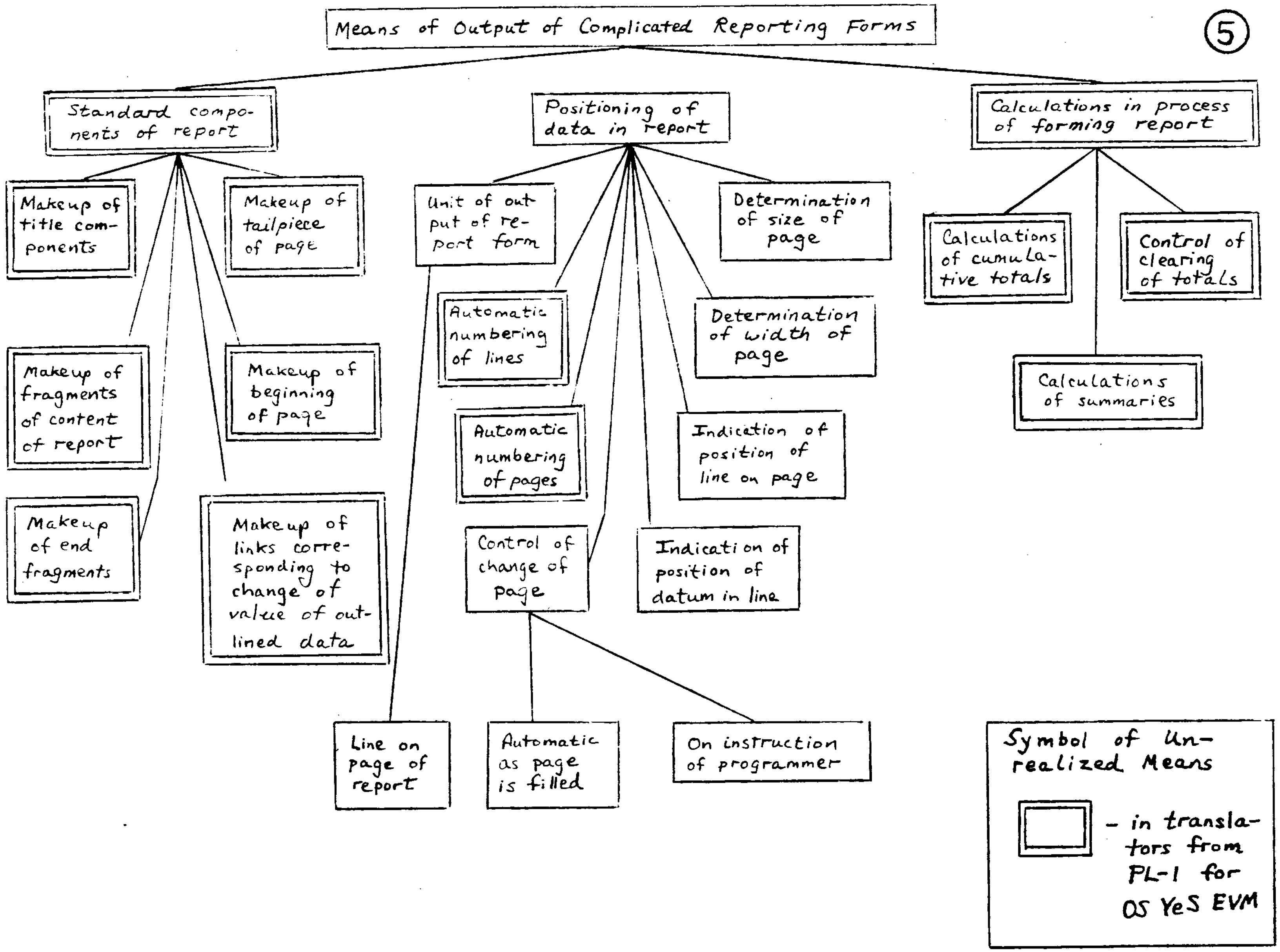

1
Means of Input-Output
Types of structures of storage of data in auxiliary storage
Unit of access
Datum from flow
Entry
Permissible methods of access
Sequential
Arbitrary
Possibility of bufferization of entries upon access
Standard access operators
Preparation of file for operation
Reading from file
Creation of file
Updating of file
Possibility of reaction of user to special access situations
File
Organization of file
Establishment of conformity between name of file and types of components of its entries
Possibility of dynamic change of access method during processing of file
Exclusion of entries from file
Supplement of file with new entries
Replacement of entries in file
Possibility for user to control
Sequential
Index
Relative
Direct
Replacement of volume
Tape rewind
Direction of review of tape
Symbols of Unrealized Means
- in translators from PL-1 for OS YeS EVM
- in translators from COBOL for Unified Computer System



2
Means of Processing Strings
Type of string
Operations on strings
Of constant length
Of variable length within indicated maximum
Maximum length indicated clearly
Maximum length determined dynamically
Isolation of substring
Assignment of value to substring
Check of entry into string
Chaining
Comparison of strings
From set position
Decomposition of string into separate substrings
Modification of locator of position
n bytes
Up to delimiter
Through delimiter
Through specification of substructures
Calculation of number of isolated positions
Calculation of number of substrings
Of given substring
Of each of given type-characters
Calculation of number of entries
Fixing of position of entry
Substitution
Replacement of all entries of given type-character
Replacement of entries up to delimiter
Replacement of all entries of substring
Fixing of number of type-characters of result
Of two strings
Of elements of structure
Of n strings
Up to delimiter
Of equal length
Of different length
Determination of ordering of alphabet of representation of strings
Symbols of Unrealized Means
-in standard of COBOL
-in translators from PL-1 for OS YeS EVM
-in translators from COBOL for Unified Computer System
-in translators from PL-1 for DOS YeS EVM



Means of Processing Tables
3
Means of determining tables
Retrieval of element of table, which satisfies the condition
Determination of ordering of elements of tables
Sequential scheme of scanning
Nonsequential schemes of scanning
From first element of table
From indicated element
Means of Reordering Data
4
Reordering of data within entry
Reordering of entries in file
Merging of two identically ordered files
Determination of ordering of alphabet
Use of special processing of entries in process of reordering
Determination of sorting of area
Symbol of Unrealized Means
– in translators from PL-1 for OS YeS EVM



Means of Output of Complicated Reporting Forms
5
Standard components of report
Makeup of title components
Makeup of tailpiece of page
Makeup of fragments of content of report
Makeup of beginning of page
Makeup of end fragments
Makeup of links corresponding to change of value of outlined data
Positioning of data in report
Unit of output of report form
Determination of size of page
Automatic numbering of lines
Determination of width of page
Automatic numbering of pages
Indication of position of line on page
Control of change of page
Indication of position of datum in line
Line on page of report
Automatic as page is filled
On instruction of programmer
Calculations in process of forming report
Calculations of cumulative totals
Control of clearing of totals
Calculations of summaries
Symbol of Unrealized Means
- in translators from PL-1 for OS YeS EVM

As is evident from this diagram, the set of operations of the processing of strings in the standard of COBOL surpasses the corresponding means of PL-1 in the number of possibilities, the main ones of which are the following:

the processing of strings, which are controlled by delimiters (by delimiter there is understood the sequence of type-characters, which is set by the user and plays the role of the boundary of the substrings being isolated in the string);

a number of operations on the strings are richer in their functional possibilities: in executing the operation the number of entries of the substring, which meet some condition, is calculated at the same time, the locator (index) of the observed position of the string and so on behaves automatically and modifies itself.

At the same time in PL-1 a richer set of types of strings (strings of bits) and the dynamic setting of the maximum length of the string are permitted.

Means of Processing Tables. These means are oriented toward the element-by-element scanning of the table and the location of the position of its elements which satisfy the set conditions. The scanning can be carried out starting with the first element of the table or with the element, the number of which is indicated by the user; the scheme of the scanning can be sequential, element by element, or more high-speed schemes of scanning, for example, binary retrieval, can be used.

As is evident from Diagram 3, in both COBOL and PL-1 the means of the specification of the tables and the access to its individual elements are provided for.

In PL-1 the means of processing tables are not clearly provided for on the problem-oriented level, although the sequential scanning of the table can be realized by three operators (using the operator DO... WHILE); in COBOL there are special operators of the retrieval of the elements of the table according to the set condition. Moreover, if the order of the elements of the table is specified, both sequential retrieval and more rapid schemes of scanning, which are determined by the implementation, are possible (just as in the version of COBOL for the Unified Computer System binary retrieval is realized).

Means of Reordering Data. By the reordering of data we will understand the rearrangement of the individual fields within one entry or the reordering of the entries of a file according to the values of some element of these entries. Diagram 4 shows that the means of reordering the data within entries are functionally equivalent in both of the languages in question (the operator of assignment with the variant BY NAME in PL-1 and the operator ARRANGE ACCORDINGLY in COBOL). The means of reordering the entries in the file and of merging two identically ordered files are clearly specified

in the versions of COBOL in question and are absent in PL-1, although there is the possibility of turning from the program in PL-1 to a systems program of collating sorting. The means of COBOL in question make it possible to determine the area of sorting, to control the transmission of entries to this area and from it and to set the order of the alphabet, according to which the comparison of the keys of the sorting is made.

Comparison of the Reporting Documents of Complicated Forms. In this section there are discussed the means of the organization, formatting, making up and presentation of the contents of reports of complicated forms, which make it possible to save the users from the writing of procedures of the positioning of data in the line being printed, the calculation of the number of lines on a page, the number of the pages, the making up of the lead and end lines of each page and other similar operations (Diagram 5).

In PL-1 the means of the category in question are realized on the procedure-oriented level and make it possible only to specify the dimensions of the pages of the report being printed horizontally and vertically, as well as to indicate during the output of the next datum or a group of data the position of the line on the page or the position of the datum in the line. There is also the possibility of indicating the omission of several lines of the page and the omission of positions in the line. In COBOL the means in question are fulfilled completely on the problem-oriented level, which allows the user to describe in the section of the data, in what form he wants to see his report, after which the formation of the report is carried out using the single operator GENERATE, which contains as the only parameter the name of the report or its components. A report is defined as some structure which contains standard components which are the following sets of data:

those printed at the beginning of the report (the heading of the report);

those printed at the end of the report;

those printed above each page of the report (the heading of the page);

those printed below each page of the report (the tailpiece of the page);

those printed with the replacement of the values of some other data, which are noted by the user;

the data which represent the content proper of the report (fragments of the report).

Each of the enumerated components is, in turn, a structure, for the elements of which the positioning on the page and in the line is specified. The user controls the appearance in the report of components such as fragments, the remaining types of components of the report are automatically provided by the system of programming in COBOL. The values of the elements of each of

the components can be set either by type-characters or by a reference to some datum, including the system-maintained registers of the number of the pages and lines of the report, or as a result of the summation of the set values (perhaps, there are added up only the values of the data, which correspond to the identical values of the other data which are outlined as control data). Thus, the simplest problems of data processing such as the formation of compendiums for different cross-sections of data are fulfilled in COBOL using the description of the forms of output and the single operator GENERATE, while when using PL-1 it is necessary to construct rather voluminous programs for the achievement of the same goals.

Conclusion. In writing this article the author did not make it her goal to convince the readers that one of the languages in question is subject to censure and prohibition, while the other should be approved as the only "legal" one. Apparently, for each of the examined languages it is possible to determine the classes of problems, for which its use will substantially increase the efficiency of programming. However, when selecting the appropriate programming language it is necessary to carefully analyze the standard functions of data processing and their proportion in the problems being examined, in order to estimate how much the presence or absence of the corresponding means in the candidate language will influence the rate and cost of the programming. The examination of standard problems of automated control systems shows that COBOL is effective for the majority of them. The exception is complicated problems, which combine the processing of complicated information structures with much computation work, as well as problems of systems programming, for which it is more feasible to use PL-1.

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BOOK OFFERINGS OF IZDATEL'STVO 'NAUKOVA DUMKA'

Kiev UPRAVLYAYUSHCHIYE SISTEMY I MASHINY in Russian No 2, Mar/Apr 78
pp 66, 105, 109

/Abstracts of new books/

/Text/ "Kibernetika i vychislitel'naya tekhnika" /Cybernetics and Computer Technology/, No 41, in Russian, 10 sheets, price: 1 ruble 50 kopecks.

Urgent problems of medical cybernetics are examined: problems of the optimization of the treatment process, the principles of the construction and development of the software of medical information systems, diagnosis, the prediction using computers of the course of illnesses, bioelectrical control, technical means, the results of the practical use of medical information systems, the modeling of individual organs and systems of the human organism.

The collection is designed for scientists, engineers, physicians, graduate students and students, who are interested in the problems of medical cybernetics.

"Kibernetika i vychislitel'naya tekhnika," No 42, in Russian, 10 sheets, price: 1 ruble 50 kopecks.

Published in the collection are articles devoted to the electrodynamic theory of circuits, which generalizes the classical theory of electrical circuits and uniform lines. There are examined the questions of the application of the methods of the electrodynamic theory of circuits to the evaluation of multiple-wire instructional systems, the band devices of ultrahigh frequency equipment, integrated circuits. A number of articles of the collection are devoted to the application of the method of secondary sources for the evaluation and planning of various electrical engineering and electronics devices, to the theory of the electromagnetic field and to analytical methods of solving border value problems.

It is designed for engineers, scientists and graduate students, who are interested in the theory and methods of evaluating electrical engineering and electronics devices.

R. Ya. Chernyak, "Periferiynoye ustroystvo TsVM na magnitnykh kartakh" /The Peripheral Unit of a Magnetic Card Digital Computer/ (in Russian, 103 pp, price: 75 kopecks).

The monograph is devoted to the question of increasing the efficiency of the technical means of data processing by using magnetic cards as the bearers of information. The unified system of technical means designed for the construction of external devices, which was developed at the Institute of Cybernetics of the Ukrainian SSR Academy of Sciences, is examined. A number of the external devices of digital computers, which are designed on the basis of the technical means of the system, are described. The expedience is shown and an estimate is made of the economic efficiency of the use of magnetic cards for the development of complexes for the preparation and input-output of information.

It is designed for engineering and technical personnel and scientists who are specialists in the field of digital computer technology and automated control systems. It can be useful to students of VUZ's and graduate students of the corresponding specialties.

"Tochnost' i nadezhnost' kiberneticheskikh sistem" /The Accuracy and Reliability of Cybernetic Systems/, No 6, in Russian, 10 sheets, price: 1 ruble 50 kopecks.

Theoretical and applied problems of the accuracy and reliability of various types of cybernetic systems and devices are examined in the collection. Methods of the analysis and assurance of the accuracy of the solution of specific classes of problems are set forth. There are examined the questions of the synthesis and determination of the indicators of the quality of the systems of control of complicated multiparameter objects, the optimization of the performance of complicated systems, the problem of the control and diagnosis of discrete devices.

It is designed for engineers, scientists, graduate students and students, who are engaged in the elaboration of questions of the accuracy and reliability of technical systems, their assemblies and blocks, as well as for specialists who are engaged in the designing and operation of complicated systems.

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CYBERNETICS, COMPUTERS AND AUTOMATION TECHNOLOGY

UDC 681.7.326.3

COMPUTERIZED INSTRUCTIONAL PROGRAM

Kiev UPRAVLYAYUSHCHIYE SISTEMY I MASHINY in Russian No 2, Mar/Apr 78 pp 127-128

/Article by engineer Yevgeniy Anatol'yevich Alekseyenko, Candidate of Technical Sciences Aleksey Mikhaylovich Dovgyallo, engineer Inna Khaskelevna Kosaya, engineer Ol'ga Pavlovna Nebrat, Candidate of Technical Sciences Boris Alekseyevich Platonov, Institute of Cybernetics of the Ukrainian SSR Academy of Sciences (Kiev): "SPOK--the System of Programming and the Support of Maintenance and Instructional Courses"/

/Text/ The creation of automated instructional, training and service dialog systems on the basis of computers is becoming at present one of the main directions which are ensuring both the efficient training of specialists of various categories and the acceleration of the introduction of computers in the national economy /1/. If, for example, a package of applied programs is given a dialog instructional program, which ensures the automated training of potential users of the given package, the following advantages are available:

the use and introduction of the package are facilitated and expedited;

the developers of the package in many ways are released from the detailed training of the users, providing only introductory acquaintance and consultations on the material, which cannot be mastered using an instructional program;

there is facilitated the work of the subdivision of accompaniment, which might not examine all the subtleties of the specific program product, ensuring only its content in conformity with the instructions on the use. The System of Programming and the Support of Maintenance and Instructional Courses (SPOK), which was developed at the Institute of Cybernetics of the Ukrainian SSR Academy of Sciences, makes it possible:

to use computers for the giving of assistance, instruction and the testing of the knowledge of tens of users who are working on the computer simultaneously with individual dialog programs (courses);

to substantially expedite and facilitate the process of creating applied instructional and maintenance programs for diverse uses;

to provide the administration of an educational institution or computer center with the necessary data on the course and results of the automated instruction and servicing of users.

The SPOK system is a package of special-purpose applied programs and is a dialog system of real time, which realizes for the servicing of the users a time-sharing mode. SPOK serves four categories of users: the supervisor, the authors of instructional courses, instructors and those being instructed. Each type of user has in the system his own language means and interacts with it in the dialog mode.

The preparation of the system for operation and the connection of the users with it take place in the following manner. First the computer operator upon a special instruction, relying on the available configuration of the hardware of the computer of the Unified Computer System, implements the generation of the programs of the package. Then the supervisor, who is the administrator of the system, comes into contact with it, registers in the system the instructional courses, the authors who will create them and those being instructed--the users of the applied programs. Further, in the process of the operation of the system, the supervisor keeps track of the correctness of its operation, the efficiency of the use of the courses and the resources of the computer. After the completion of the registration, as well as the arrangement of the already prepared courses, those being instructed and the authors are set to work with the system.

SPOK ensures efficient programming and the support of the subsequent main modes of interaction with the users of the applied programs (those being instructed):

the receipt of advice or information (such as the "menu" [2]);

programmed instruction [3];

the diagnosis of the needs and/or knowledge of the user with his subsequent referral to the appropriate printed materials;

the testing of knowledge, abilities and skills with the presentation of an evaluation and the opening of the record of the test;

an instructional-reference mode;

machine-managed programming in a language unknown to the user (the mode of a system like DIPROFOR [4]) and others.

The authors are specialists in the subject field on which the dialog course is being written. Included in their tasks are the methodological study of

the content of the course, the development of the script and program of the dialog, the writing of the program in the Language of Description of Courses (YAOK), its introduction in the library of SPOK and the debugging of the introduced program. YAOK is simple to learn and accessible to authors who do not have special training in the area of programming and computer technology. A reference course in YAOK is also constantly available in the library of SPOK to assist authors.

YAOK contains about 30 operators, which on the general level can be broken down into three main groups. The first group of operators ensures the output of the texts of educational and auxiliary information, test questions, instructions and so on. The second group of operators ensures the analysis of the answers read in by those being instructed. The methods of this analysis may be different, for example, the comparison with a standard, the finding of key words, the obtaining of a model of the answer and work with it and so forth. Finally, the last group of operators of YAOK makes it possible to organize in the program of the course transfers from one tag of the program to another when specific conditions arise.

YAOK is open for expansions which can lead to new possibilities of the system. For this in SPOK there are means which make it possible to include in YAOK subprograms which have been written in ASSEMBLER, PL/1, COBOL and FORTRAN.

The instructors and consultants help those being instructed in their work with the instructional courses. By utilizing the statistical data on the course of the instructional process, which are put out at the terminal, the instructor can actively intervene in this process. It should be noted that the presence of an instructor during the work of those being instructed with dialog courses is not necessary.

The functional structure of SPOK in general form can be represented as consisting of the following components: the configurer, the initializer, the control program, the interpreter, the library and the archive. These components under the management of the DOS YeS accumulate, store, present and back up the dialog courses prepared by the authors.

The configurer at the stage of the generation of SPOK describes the necessary configuration of the system, while the initializer during the start of the system checks the real technical and program situation (programs, the necessary files, data, protection against errors and so forth).

The control program ensures the servicing of the terminals of the users, organizes the connection between the files which are in different devices of the system, corrects arising errors and keeps track of the passage of the jobs in the system, which are caused by communications of the users.

The interpreter ensures the interpretation and execution of the operators of the YAOK and the instructions of languages of different categories of users.

The library ensures the storage in the system of applied dialog programs (courses). Up to 420 programs can be stored simultaneously.

The archive is designed for the storage of data on the work of the users, as well as information on the operation of the system itself.

For the operation of SPOK a version of DOS YeS is necessary, which includes a program of the base telecommunications method of access VTAM. SPOK can occupy any of the sections of the DOS YeS. For the minimum configuration of SPOK there are constantly necessary the following resources for the models of the Unified Computer System, beginning with the YeS-1020 and higher:

an operational memory--not less than 44K bytes;

magnetic tape storages like the YeS-5052--one (personal libraries);

magnetic tape storages like the YeS-5017--not less than two;

the YeS-7906 package (in any configuration produced by industry)--one.

As the experience of use shows, SPOK makes it possible to reduce the time of the programming of dialog courses by 5-10 times as compared with programming in PL/1. A substantial reduction of the time and an increase of the quality of the learning of different subjects are also observed.

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MINICOMPUTER MONITORING SYSTEMS

Kiev UPRAVLYAYUSHCHIYE SISTEMY I MASHINY in Russian No 2, Mar/Apr 78 pp 130-131

/Article by engineer Aleksandr Yakovlevich Samardak, Scientific Production Association of the Promavtomatika All-Union Scientific Research and Planning Institute: "Monitoring Systems of Minicomputer Software"/

/Text/ In this case by monitor there is understood a control program, at the disposal of which there are the following resources: a compiler, an editor of symbol information and a symbol file.

The exchange of information through the console of the operator--by keys and through the input-output device of the symbol information takes place between the monitor and the operator.

In the currently widespread series of M6000 minicomputers the punched tape software /1/ is designed for a minimum memory capacity of 4-8K words, which makes it possible to accommodate only one systems program: the compiler (or a part of it), the editor of the symbol information and so forth. Organizations engaged in the production of special software, as a rule, acquire immediate-access storages of 16K words and more, hoping subsequently to increase the capacity of the computer system by means of external magnetic tape and disc storages with the appropriate operational systems.

A memory of 16K words makes it possible to accommodate several systems programs for the processing of the text. Under these conditions it is necessary to modernize the standard system-wide software. With the operator operation of the computer system (without the access of programmers) the creation of monitoring systems is a means of modernization at the stage of translation and editing. The use as a monitor /2/ of an Assembler editor of symbol information proved convenient to use and showed great self-maintainability in the event of restarts in cases of a break from the circuits of control of the processor and arbitrary halts from the operators. At the Scientific Production Association of the Promavtomatika All-Union Scientific Research and Planning Institute monitors with the compilers ALGOL-60 and FORTRAN-II of the M6000 were designed on the basis of this monitor. Each of

the monitors makes it possible to input the initial texts, to repeatedly edit and translate the symbol file and to punch the symbol text.

The capacity of the programs being processed in practice is limited by the size of the symbol file, which at most can have about 2,000 strings in Assembler or 800-1,000 in ALGOL or FORTRAN. The change of the operating mode of the monitors takes place under the effect of the instructions:

:A, :H, :F are correspondingly the instructions of the transfer of control to Assembler or to the compiler with ALGOL or FORTRAN;

:T is the instruction of the input of the symbol file from the punched tape;

:L is the instruction of the printing of the sequentially numbered strings of the symbol text which is contained in the immediate-access storage;

:P is the instruction of the punching of the symbol text;

:B, :E are the instructions of the tranfer of control to the editor of the symbol information. The editing is carried out by the texts either from the punched tape or from the keyboard.

The editor also works on the control of two-symbol instructions of the replacement, insertion and elimination of strings of the text. The instructions can have numerical parameters. For example, the instruction :P 2,5 means perforation from the 2d through the 5th strings of the symbol text.

The monitors with ALGOL and Assembler have the greatest coincidence of algorithms.

The monitor with a compiler from FORTRAN is distinguished by the existence of doubles of two phases of the compiler in the external area of the storage, a subprogram of the creation of a binary intermediate file during the operation of the first phase of the compiler and a subprogram of the reading of the intermediate binary file during the operation of the second phase.

The first phase of FORTRAN is rewritten into the area of execution and is activated by the instruction :F, the second phase is rewritten and receives control on the condition of the creation of at least one entry of the intermediate binary file, otherwise the control is transferred to the monitor, which shifts to the mode of expectation of an instruction.

Control by the key register is maintained in the monitors. The pressing of the zero key (or the 15th key for a monitor with ALGOL) causes a jump to expectation of instructions. Control by the 2d key (or the 14th key for a monitor with ALGOL) has been added, which causes the output of the listing or numbered text, depending on the preceding instruction, on the punched tape.

The set of tapes of the monitors ensures the high speed of the processing of the texts at the stage of translation-editing in the operational system at the computer center. The monitoring system is an effective means of teaching programmers the programming language, and permits the programmers to deal more tolerantly with the punched tape software.

In the case of the combination of the work with interpreting systems like BASIC /1/, ASTRA /3/ and the translation and editing of similar texts in the monitoring systems, the periods of the creation of programs of the special software in FORTRAN and Assembler are accelerated.

The set of tapes of the monitors is distinguished from the system described in /4/ by a small number of functions (the lack of a moving loader), but by more convenient control by the main mode-instructions than by the keys of the console of the operator.

With the introduction into operation of a disc operational system the set of tapes of the monitors remains a competitive means of processing programs, owing to the minor exchange of information between the operator and the program under different situations and the high rate of processing of the symbol file contained in the immediate-access storage.

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SYMBOL INFORMATION OUTPUT PROGRAM

Kiev UPRAVLYAYUSHCHIYE SISTEMY I MASHINY in Russian No 2, Mar/Apr 78 p 136

/Article by engineer Aleksandr Grigor'yevich Rukshin, Special Start-Up and Adjustment Administration of the Sevzapmontazhavtomatika Trust (Leningrad): "A Symbol Information Output Program With Bufferization of Communications and Redundancy of Input-Output Devices for the M6000 Automated System of Computer Technology"/

/Text/ The problem of the organization of the output of symbol information in real time with greater reliability arises when creating the software of ASUTP's /automated control systems of technological processes). For the operation of the system of real time it is necessary to organize the bufferization of the output communications.

When using nondisc variants of M6000 computer complexes of ASVT's /automated systems of computer technology/ the bufferization of communications is organized only in the Operational System of Real Time (OS RV). But the OS RV with its library of standard programs occupies a large amount of the working storage. The proposed program uses the Main Control System, the dispatcher of real time,* the library of nonreenterable programs and has the following advantages:

it automatically (without the participation of the operator) replaces the failed input-output device (UVV) with another;

if in the buffer there is no room for the communication of the program which requested the output, the possibility of making a decision on further actions is afforded (in the OS RV the program is halted until the entry of the communication in the buffer);

through the UVV there can be simultaneously organized both two flows of communication--ordinary (with bufferization) and priority (unbuffered) and any of them;

*A. G. Rukshin, "The Dispatcher of Real Time," UPRAVLYAYUSHCHIYE SISTEMY I MASHINY, No 5, 1977, pp 58-59.

the communications in the output buffers are stored in binary notation and are converted into symbol notation only before output, which makes it possible to condense the package of communications and to decrease the size of the output buffer.

Circuits of redundancy of the UVV are organized to increase the reliability of the channel of output of communications. The number of circuits in the system is chosen arbitrarily. The UVV can be included in several circuits. The inquiry for the output of a communication indicates the number of the output circuit and the type of output (usual or priority). If the output is usual, an entry is formulated which is entered in the buffer of the communications of the indicated circuit. After this the control is returned to the generating program. If there is insufficient room in the buffer for the arrangement of the string, the control is returned to the generating program with the indication of rejection. With a priority output the status of the buffer of the given circuit is analyzed. If the buffer is vacant, the communication is transformed according to the set format and is placed in the priority buffer; if the buffer is occupied or the circuit does not have a priority buffer, the order is considered unfulfilled and the generating program receives control with the indication of rejection. With the receiving of control with the indication of rejection the program of the user can refuse further attempts at the output of the communication or continue them. Each inquiry for output realizes the output of one string. A multistring output is realized by a sequence of inquiries.

The organization of several circuits of UVV's and the possibility of including one UVV in different circuits make it possible for less important communications to use the reserve UVV's, increasing the carrying capacity of the channel of output of communications and the degree of redundancy for the priority circuit itself.

The output of communications from the buffers is achieved by the individual problem of real time, which scans a special program array of circuits, analyzes the status of the buffers and, when there are inquiries for output in the buffers, transforms the information in the set format and reads it out to the first serviceable UVV in the indicated circuit. If the UVV after a certain time has not read out the string or an error of transmission has taken place a certain number of times, the UVV is considered unserviceable. In the next UVV in this circuit a communication on the rejection of the preceding one is issued and the output of the communications continues. If there is an order for the priority output of a string, it is fulfilled before the next order for a usual output.

Each circuit of the UVV has a logical number, and communications of the circuit with a smaller number have a higher priority. If communications of several circuits of redundancy are read out simultaneously to one UVV, the inquiries of the higher priority circuit are met first.

The setup of a program on a specific configuration of technical means is carried out during the formation of the array of circuits, which is written

according to a specific format in mnemonic code, is translated and loaded by moving loaders.

There is the possibility of the automatic rehabilitation of the failed UVV's after a set interval of time.

The use of the proposed program makes it possible to organize a reliable channel of output of communications, which meets the requirements of real-time systems.

The program was developed at the Leningrad Specialized Start-Up and Adjustment Administration.

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OFFICIAL DISCUSSES AUTOMATED SYSTEM OF MANAGEMENT

Moscow EKONOMICHESKAYA GAZETA in Russian No 23, Jun 78 p 13

[Article by K. N. Rudnev, Minister of Instrument Making, Automation Equipment and Control Systems USSR: "Under Conditions of the New System of Management"]

[Text] In the most recent issue of this weekly the editors began publishing the proceedings of the Second All-Union Conference on Employment of Computer Hardware and Automated Management Systems in the Economy with an article by D. G. Zhimerin, First Deputy Chairman of the USSR Council of Ministers State Committee on Science and Technology, entitled "Qualitatively New Stage."

In this issue we are publishing succeeding articles under the section heading "Effectiveness of Utilization of ASU [Automated Management Systems, Automatic Control Systems]."

L. I. Brezhnev stated in his report at the 25th CPSU Congress: "It is necessary first and foremost to ensure major improvement in planning.... There is a broad area here for application of the efforts of economic science and for the adoption of modern scientific methods, including economic-mathematical, and for utilization of automated management systems."

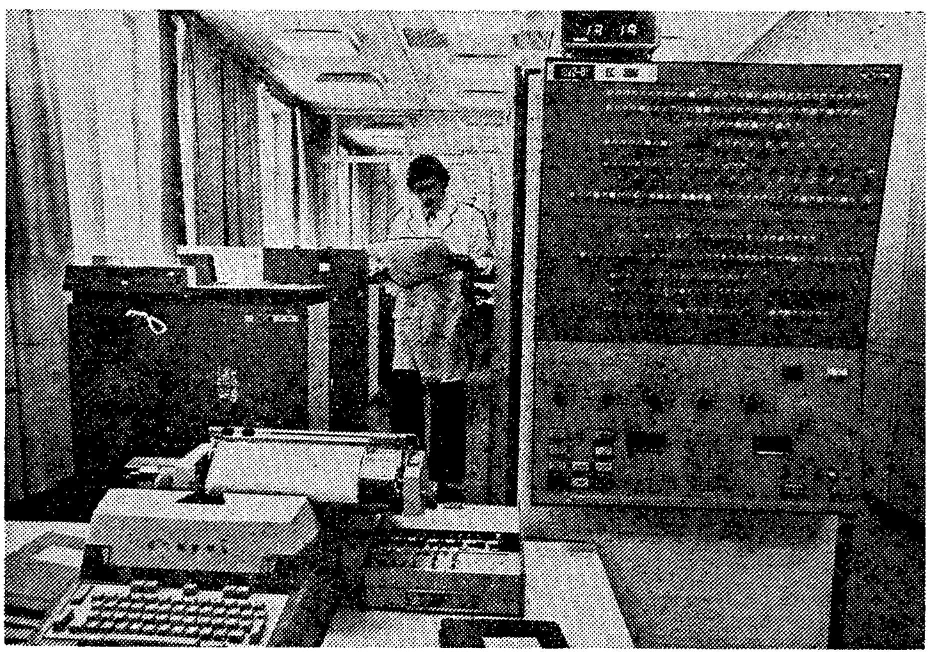
At the Highest Level of Management

In our branch there is functioning an OASU [Branch Automated Management System], with the aid of which the complex mechanism of management was raised to a new level. It presently combines modern economic-accountability conditions of operation with the potential of economic-mathematical methods and electronic computer hardware. The employed system ensures sufficiently full and comprehensive automated processing of data requisite for performance of the principal functions of control in the area of long-range and current planning, day-by-day production control, product quality control, management of labor, material and financial resources, capital construction, marketing and transport operations.

The branch's EDP center contains four computers. The data obtained from them enable ministry officials quickly and efficiently to assess the state of affairs in the branch and when possible to take prompt measures preventing deviations from the plan-specified targets.

We are endeavoring to ensure that the EDP center is able to utilize improved computers and data handling equipment, ensuring the processing and presentation of analytical information in package form on equipment making it possible to perform multiple-variant optimized calculations, as well as automated preparation of data on magnetic media.

Internal software support should include operation and test systems, a remote control information processing system, a broad group of packages of applied programs and a data bank management system. Improvement of EDP is figured for serving a branch which contains hundreds of enterprises and organizations. It is to provide solution to 600-700 economic problems.



The Novocherkassk Electric Locomotive Plant — one of the Soviet Union's largest. Planning, accounting and record keeping, management and analysis of performance of production targets are performed here with the aid of an enterprise automated management system. The photograph shows the plant's electronic data processing center, which is equipped with Ryad system computers.

We have not yet reached the desired level. ASU-pribor [Instrument Engineering Automated Management System] will go into full-scale operation in 1980.

Practical work performed at the ministry in the area of automated system adoption faces us with a number of tasks pertaining to its further improvement.

There has arisen the need to establish an integrated system optimally coordinating into a unified whole enterprise and association ASU and the branch ASU. This does not mean that we are endeavoring to establish an automation system which would link the ministry control center with each and every work station. But we strongly feel that it is essential to be fully informed on what is being done directly in this branch's sphere of material production and to be able systematically and promptly to affect the course of events. It is no less important for each director to be able to know what is being done at each work station which is of importance for meeting the enterprise's plan-specified targets.

Of course stepped-supervision by the ministry with the aid of computers should not diminish the role and responsibility of supervisory personnel of existing management levels -- foreman, shop superintendent, production chief, plant director. We know that man continues to play a determining role in any "man-machine" system. A computer cannot replace the personality factor in production management and supervision of the operations of sections, shops, enterprises and associations.

One of the tasks of management automation is faster presentation of requisite objective information, to reach suitable decisions and thus to create for managers conditions making it possible quickly and efficiently to affect controlling entities, reducing expenditures of time and energy and, most important, increasing the efficacy of decisions.

Branch on Economic Accountability

The last decade has been for the Ministry of Instrument Making, Automation Equipment and Control Systems years of development and adoption at enterprises of a new system of planning and economic incentive, followed by sequential spread of economic-accountability principles to industrial complexes of subbranches and the branch as a whole. Life itself has shown us that further improvement in production efficiency is impossible without making up the gap in management methods at the lower and middle echlons of management, based on economically expedient principles.

Transition of the entire branch over to full economic accountability made it possible to bring the forms of organization and production management methods into conformity with the demands of maximum efficient utilization of labor, material and financial resources. A three-level system of management was made the basis of the organizational structure of this ministry in 1970: ministry-all-union industrial association-production (scientific-production) association, enterprise.

The main feature of the new system of planning and financing consists in increasing the economic responsibility of the ministry for meeting the indices of the national economic plan, independent of the performance of individual enterprises and associations. Our activities are based on the five-year plan, with year-by-year distribution of targets. Each year there is refinement and detailing of the item list by the major products, and extended plans for the associations and enterprises are approved in conformity with the needs of the national economy, coordinated with USSR Gossnab. Contract work volume in capital construction for ensuring completion of industrial facilities specified for the five-year plan is detailed with USSR Gosplan, broken down by executing entity.

Planning of payroll and distribution of profit between the state budget and the branch are effected on the basis of long-term standards approved by USSR Gosplan, elaborated taking into account the specified labor productivity growth and progressively-increasing percentage of profit contributed to the budget.

The amount of standard profitability is determined from calculation of covering the outlays of the branch, including for expanded reproduction, from local financial resources, and the calculations provide for a steady decrease in production cost and the percentage share of allowances for the outlays of the branch. The toughness of the accumulations targets is due to a sharp increase in the percentage of profit contributions to the budget in cases of overfulfillment of targets for this indicator by more than 2%.

The branch settles accounts with the budget strictly on the basis of specified standard amounts, proceeding from the profit amounts ratified in the plan, independent of the performance of each enterprise or association. If they lack the necessary resources, their budget liability is covered with the resources of the corresponding all-union industrial association or ministry. Full economic responsibility of the branch, based on firm ministry guarantees, is manifested in this.

Following transition by the branch to economic accountability, material incentive has also been increased. The management edifice of the all-union associations as well is rewarded for concrete results, including for meeting the target for production and product sales in a broad product list.

The requisite economic and organizational preconditions have been created in this ministry for speeding up technological progress. In particular, financing of science and design projects is now handled from a single science and technology development fund on the basis of orders specifying the entire work cycle -- from development to incorporation.

The complex of intercoordinated indices on the basis of which the performance of the branch, associations and enterprises is evaluated makes it possible for the all-union industrial associations and the ministry edifice to perceive omissions and blunders occurring in the activities of individual enterprises.

The economic responsibility of the branch for the performance of each enterprise advances to the forefront the task of increasing the responsibility of the enterprises proper to the ministry and makes it absolutely essential to strengthen supervision on the part of the all-union associations and ministry edifice for progress in meeting national economic plan targets, and at the plan elaboration stage -- for adopting tough but realistic targets. Therefore it is essential here to receive prompt, reliable information on the activities of each enterprise. And this task is accomplished with computers and automated systems of all levels.

Thus one is entirely warranted in stating that the new economic content of the methods of economic management -- full economic accountability -- constitutes a powerful incentive to improve management and business operations both at the lower echelons of the industrial complex and in the ministry edifice. Branch and enterprise ASU are becoming an important instrument which is helping accomplish a great and responsible task -- improvement of efficiency and quality.

Further development of economic accountability involves transition by the all-union industrial associations to the normative method of profit distribution. This process was essentially completed in the Ministry 2 years ago. As a result there has been a rise in the level of economic work, since the economic responsibility of the all-union associations forces their management edifice constantly to improve day-by-day supervision of the activities of the enterprises and associations.

I should particularly like to emphasize a very important factor which proceeds directly from expansion of economic-accountability principles of maangement -- the greater opportunities for development of initiative in production management and improvement of production.

The established procedure of planning and economic-accountability management for the ministry in some items connected with utilization of development funds affords the opportunity to channel them at the ministry's discretion in conformity with concrete conditions, for achieving the greatest end economic effect.

Ways to Improve Management

During the period which has passed since the branch was changed over to the new system of planning and economic incentive, a wealth of factual material has been amassed, making it possible to speak confidently on the necessity of employing economic accountability in other ministries. However, although nobody denies the expediency of this, practical steps in this direction are being taken very slowly. Up to the present time only the Ministry of Heavy and Transport Machine Building and the Ministry of Agricultural Machine Building have been changed over to the branch economic

accountability system. Therefore a number of difficulties are arising in the operations of our ministry, which cannot establish relations with other branches on the basis of identical indices and performance evaluation criteria.

It is desirable more rigorously to approach securement of stability of long-range plans and wholesale prices. It is essential to strengthen the interrelationship between planning and pricing. Certain discrepancies between the branch's planning and financing system and the procedure of changing wholesale prices at times have an extremely negative effect on enterprise performance. This disturbs planning-finance discipline to a substantial degree, since the question of redistribution of profit is extremely complicated due to the lack of a mechanism which determines the consumers of a product prices on which have been changed. These circumstances compel one to change previously-coordinated economic indices, making them essentially reference indices for reporting but not for management during a plan-covered period.

Certain difficulties also arise due to the fact that the automated systems operating in the branches and at enterprises have not been boosted to a volume of data processing and level of equipment whereby it would be possible to shift to accomplishing management tasks by means of optimization, while the method of economic management adopted by the ministry imposes on ASU-pribor higher demands both as regards completeness and comprehensiveness of analytical data and at the level of reliability of results of calculations presented to management personnel.

Obviously the experience of the Ministry of Instrument Making, Automation Equipment and Control Systems cannot be viewed as universal and totally acceptable for all industrial ministries. At the same time we believe that it can be innovatively utilized by other branches in their work to improve production management on the basis of the principles of economic accountability and economic-mathematical methods.

3024
CSO: 1820

GUARANTEE OF THE RELIABILITY OF ORBITAL STATIONS

Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 6, 1978 pp 34-35

[Article by V. Simayev, candidate of technical sciences]

[Text] The level of development of astronautics achieved after launching the first artificial earth satellite and the first manned flight in space, the successful solution of many complex scientific, engineering and medical-biological problems are making it possible to make long-term manned space flights.

This is convincingly demonstrated by our 96-day expedition on Salyut-6. During the entire flight the onboard systems and equipment of the station and the spacecraft operated normally. The successful performance by the astronauts Yu. Romanenko, G. Grechko, V. Dzhanibekov, O. Makarov, A. Gubarev and V. Remek of the planned program is evidence of the high operating qualities and reliability of the space complex permitting four dockings of the transport spaceships with the orbital station during the three-month period.

When conferring the award on the heroes of the space epopee, Comrade L. I. Brezhnev said:

"Everything was performed with excellence. The flight, the dockings and the performance of the broad program of important scientific and technical research.

"The skill and bravery of the astronauts, the selfless labor of those who prepared the flight and insured efficient, failsafe operation of the entire highly complicated space research complex have borne their fruits. A new great contribution has been made to the implementation of the resolutions of the 25th Congress of the CPSU on the development of research and the use of space for peaceful purposes."

The efficiency of the long-term operation of the manned spacecraft in orbit is predetermined by the reliability of both the orbital technical devices and the crew, the most important component link in the system for controlling and servicing this equipment. The presence of a man on board the spacecraft permits execution of the most varied programs in space having

the most important scientific and technical and national economic significance. It is true that for this purpose it is necessary to go to a defined complication of the structural elements of the equipment, the installation of additional systems on them: the regeneration of the atmosphere and gas analysis, collection of condensate, water supply, power supply and personal hygiene, means of preventing harmful effects from weightlessness, and so on. However, these complications are justified.

The structural design of the manned craft must provide not only the conditions for effective performance by the crew of the functions in which man has priority over automated devices, but also to permit him actively to intervene in the control of the onboard system, to provide technical servicing, to eliminate failures and perform repairs. Accordingly, the reliability of the manned spacecraft is higher than the automated ones. Many cases are known where the presence of the astronauts on board and their intervention have saved the flight program.

It is known that the operation of the skylab station became possible only as a result of the crew. On insertion into space its solar battery and part of the heat shield were ripped away as a result of which the temperature in the compartments rose to +50°C. The situation was made worse by wedging of the second panel of solar elements which robbed the station of a significant part of its power. The astronauts were able to eliminate this damage and restored its fitness.

The Soviet astronauts have also demonstrated more than once their high mastery when performing the repair and recovery work in orbit. The recovery of the operation of the solar telescope and one of the cameras on board the Salyut-4 station is a clear example in this respect.

The testing of the solar telescope systems went without comment. However, the astronauts were not able to work with them in accordance with the routine program. Instead of the heavenly body, the telescope mirrors persistently picked up a sunbeam which ununderstandably somehow got into the cone with the scientific equipment. Where it came from neither the crew of the station, A. Gubarev and G. Grechko or the telescope developers, engineers from the Crimean Astrophysics Observatory, could understand. Several efforts were made to deflect it away from the tracking mirror. Several versions were run on a mockup of the telescope on the ground, and recommendations were made. The astronauts worked with all four hands. The hunt for the sunbeam lasted for several hours. Gubarev and Grechko exhibited much persistence and ability. By complex movements of the station and precise operation of the tracking systems the crew succeeded in forcing the sunbeam into the corner and performing a series of observations of the sun.

The next crew on this station P. Klimuk and V. Sevast'yanov met with a highly complex failure of one of the cameras. Using the recommendations of the specialists duplicating the repair operations on an analog, the astronauts repaired the camera and successfully carried out the survey program.

Thus, when organizing long-term manned space flights we encounter the serious problem of providing the crew with conditions under which they can perform their functional duties.

During short flights it is possible to neglect some of the convenience on board the spacecraft to which a man becomes accustomed in daily life, but in long flights conditions must be created for him which are as close as possible to ground conditions. This pertains to the agenda for the day, the load, alternation of work and rest, organization of leisure time and everything that in one way or another characterizes his customary lifestyle. Otherwise sooner or later physical and psychological fatigue will occur, the fitness and attentiveness will be lowered, and the sense of responsibility will be dulled. This is very dangerous!

It is possible to object: But it is impossible to create earth conditions in space no matter how much one might like to do it. Indeed, this is so. And it is these differences that obviously will basically determine the time that man stays in space for a long time to come.

What is meant by the technical problem of providing the onboard crew of a long-term orbital station with conditions for performing their duties?

These include access of the crew to the equipment for periodic checks of the state of the onboard systems, monitoring of the values of their technical characteristics, replacement of individual structural elements, modules and assemblies as reserves are depleted or failures occur. Naturally, the implementation of such conditions is possible in the case where the crew has excellent knowledge of their equipment, where it has high professional skill in preventive maintenance and repair work.

The space equipment in orbital flight is under the long-term effect of such new factors as weightlessness, deep vacuum, a large temperature gradient (+150°C on the sunny side, 150°C on the shady side), solar radiation, and cosmic radiation. The intensity of wear and aging of the materials increases significantly in this case, and the phenomenon of cold welding of the contact metals is observed. The earth lubricants are unsuitable here. The instruments and devices the operation of which to one degree or another makes use of the gravitational force are inapplicable.

All of this must be considered by the designers when developing the spacecraft systems.

In order to improve the reliability of the spacecraft or the orbital station it is not always possible to duplicate the modules inasmuch as here, just as when creating any other piece of equipment, there are restrictions caused by the weight of the equipment, the time lost on developing it and, of course, the allocated means. Theoretically it is now possible to create highly complex devices capable of functioning an infinitely long time, for example, a television which can operate without repair for a hundred or more years. However, first, as a result of multiple redundancy of the

component elements this television set turns out to be incomparably more complicated than the existing ones; secondly, its creation will take a tremendous amount of time and, thirdly, by the most approximate calculations it will cost no less than an automobile.

However, the presence of a crew on board the long-term spacecraft permits us to find a compromise solution--in our case, to duplicate not all of the onboard systems of the station but only the most responsible from the point of view of control of the station dynamics and crew safety and also to provide the possibility for the crew to effectively monitor the fitness of the individual units, the preventive maintenance and replacement of the failed elements, assemblies and modules.

Therefore when creating the long-term orbital manned devices we are limited not only to the application of the most efficient technological processes in the manufacture of the high quality structural elements, careful assembly and the performance of a large number of varied tests. In order to improve the reliability, the possibility of repairability of its most important elements during the operating process is built into the structural design of the spacecraft.

The repairability of the manned spacecraft is characterized by a number of indexes: improvement of the structural compositional layout of the interior from the point of view of insuring simplicity and convenience of the access to the equipment for servicing, the presence of monitoring and testing equipment, the possibility of adjusting the parameters of the modules and units and if necessary replacement of the individual structural elements and also the presence on board of the required number and assortment of spare parts, working tools and various types of attachments for repair.

The degree of repairability of the manned spacecraft is determined and insured in the process of its development and manufacture. However, as has already been noted, maintenance of it in a fit condition over the entire flight is possible only in the presence of a crew with high professional training on board. Therefore the discovery of the capability of the astronauts to perform repair work in flight is of significant interest.

The flight experience has demonstrated that the astronauts can perform not only small repairs, install and dismantle a variety of equipment, replace individual modules and units, but also perform highly complex and tedious work with respect to recovering entire systems.

In order to obtain reliable scientific data in this area on board the Soviet Salyut-5 orbital station, special studies were made to discover the capability of the crew to replace the modules of the onboard systems, switch the plug boards, install small sections of onboard cable electric network. In addition, the astronauts had to perform technical servicing on one of the digital computers of the onboard computer complex. It was necessary to determine the physical forces, the time expenditures and the demand for the required attachments, tools, test and monitoring equipment.

In the opinion of the scientists and the designers these measures had to make up the set of most important operations for maintaining the spacecraft equipment.

The experiment was begun on 11 February 1977. In accordance with the program the crew performed 16 operations with respect to repair and replacement of the elements of the onboard systems and equipment. These operations included adjustment and regulation of the parameters of the technical devices and also replacement of the modules, units, cable connections and safety devices. In addition, the crew of the Salyut-5 made an expert evaluation of the component system of the station and the structural engineering properties of the equipment. It determined the degree of accessibility of the various units and individual assembles.

Inasmuch as the work done was of a purely scientific experimental nature, V. Gorbatko and Yu. Glazkov tried to obtain objective quantitative characteristics with respect to the performance of the individual operations. The latter did not cause any difficulties for the crew, but the total time spent on performing the individual types of operations was somewhat greater than obtained when working out the procedures under earth gravitational conditions. The specialists explained this fact not only by the effect of the spaceflight conditions but also the great carefulness with which they were performed.

The operating ground analog of the station was an important element in the control and support of the flight of the actual Salyut-5 orbital station. It was completely outfitted with systems and equipment that were operating in flight. It was serviced by shift brigades of trained specialists. The ground crews worked on board the space twin. They executed the flight program simultaneously with the astronauts. As a result, along with the enumerated factors, this analog came to have a significant effect on improving the reliability of the actual station. As a result of the analog it was easier to determine the efficient operations of the space crew, the more so in that it was possible to call on astronauts who had already made flights to help with developing the required recommendations, and it was possible to find the best versions of eliminating failures with the help of experienced specialists, the developers of the equipment.

Let us imagine a situation: on board the station a failure has occurred in one of the systems which has caused a changed in parameters of the other systems. According to the crew reports and the telemetric data it has not been possible to establish the cause of failure. The specialists on the ground have several proposals and propositions. Where and how are they to be checked out? The role of the analog is invaluable here. By the reaction of its onboard systems it is possible to establish the cause of failure and quickly determine the procedure for eliminating it.

The results of the studies and the operation and maintenance of the space equipment have made it possible to determine the basic requirements on the repairability and reliability of the functioning of the onboard systems of the long-term spacecraft. The most important of them unquestionably include maintenance of conditions for the crew to work efficiently. This, in turn, must be reinforced by the development of the most effective means of monitoring, repair, recovery and redundancy. Now the designers are already not satisfied with the functional breakdown of the equipment into modules. The elements of the modules of the onboard systems are being divided insofar as possible into independent parts and sections identical for different types of equipment. This makes it possible to realize the advantages of the most effective redundancy techniques. Failures have become simpler and more localized as a result of this, and the monitoring and repair have been facilitated.

The presence on board of professionally trained crew and insurance of high level of repairability of the spacecraft for scientific and national economic purposes are the most important conditions for improving the reliability and prolonged operation of the long-term spacecraft.

10845
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GEOPHYSICS, ASTRONOMY AND SPACE

FIFTY MINUTES IN HYDRAULIC WEIGHTLESSNESS

Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 6, 1978 pp 36-37

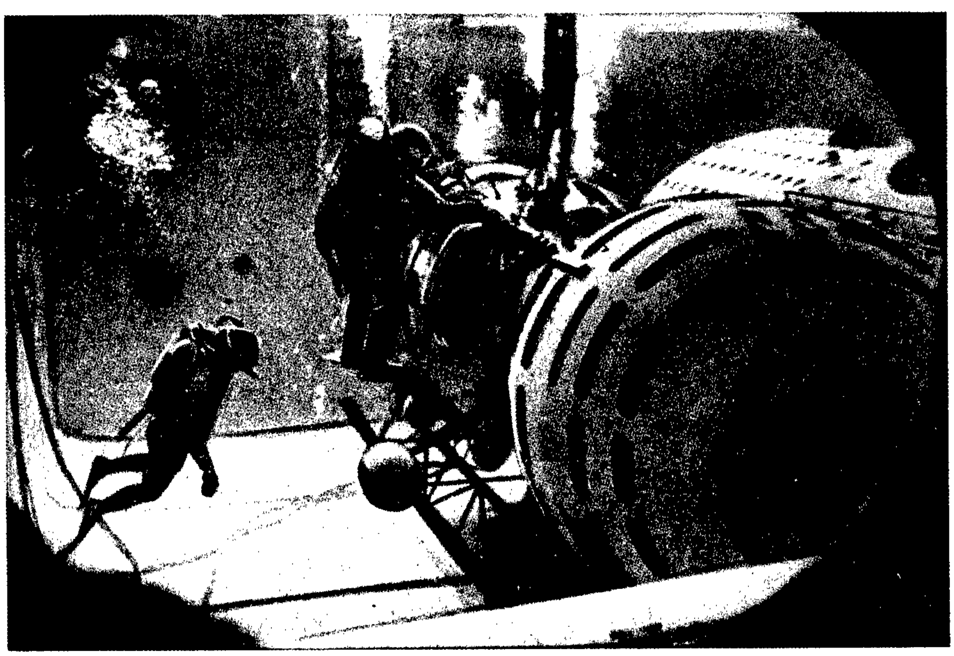
[Article by Col A. Khorobrykh, special correspondent of the aviation and astronautics journal]

[Text] Report From the Astronaut Training Center

The mockup of the Salyut-Soyuz complex is clearly visible across the blueness of the water, but there is no time to look at it.

"Time to submerge," says the doctor, checking my pulse.

The extraordinary nature of the situation is disturbing: everything is ready, and I cannot believe that I am climbing into a space suit. "That suit is a little small for you," warned the training director.



"Bravely, bravely!" retorts the doctor.

The water-cooled suit (KVO) fits snugly. I put my legs in the pants with the boots. I shove my arms through the side hinges of the cuirass, the metal base of the space suit, into the many-layered elastic sleeves. It was not so easy to get into the universal suit.

I rested for a minute. There was not much left to do--pull it up to the shoulders and stick my head in the stationary helmet with the folding gold light filter. However, this "not much" almost became a stumbling block. In any case I did not get through the cuirass on the first try.

On the second pass, as the pilots say, I made it. It cannot be said that the space suit fit perfectly. It could have been two or three sizes larger. However, after inflating the suit expanded somewhat.

"Our hydraulic laboratory is used not only for training crews before space flights," the head of the Astronaut Training Center twice Hero of the Soviet Union, Lieutenant General of Aviation G. T. Beregovoy said the evening before. "Here, just as when making flights through the 'parabola of weightlessness' in the laboratory aircraft, we are performing studies and experiments to develop and improve methods of executing many of the operations in orbit both inside and outside the station.

With zero buoyancy and indifferent equilibrium of the diving suit, water becomes to a known degree a supportless medium. This permits simulation of the working conditions of astronauts close to weightlessness conditions.

Long before launching the Soyuz-26 spacecraft studies were made in the water tank and the crew was trained for entering space through the hatch of the docking unit of the transfer compartment (it had to be checked out). The launch of the Soyuz-27 was planned for docking with the manned orbital station Salyut-6 by using this unit.

Therefore astronauts Romanenko and Grechko developed the exit procedure for the onboard engineer to examine the docking unit, transfer space tools, and for interaction in all phases of exit and other problems in the water. You, the writer, are going to do similar work underwater. I wish you success!" Georgiy Timofeyevich concluded the conversation.

The "dolphins," the procedural instructors, went into the tank first in their light diving suits. They were responsible for the safety of the experiment. After them in the newly designed semirigid space suit came the test engineer who had been assigned the role of crew leader of the orbital station.

An electric winch lowered me to the bottom of the tank. For the suit to have zero buoyancy and be indifferent is easier if there is a support!

"First, second, ready?"

"Ready."

"Everyone take their places!" By these words the training leader gave us permission from on shore to enter the station with the leader.

Here I should like to make a small digression, to say a few words about the training of the people and preparation of the equipment to work in the water environment. With respect to care and organization it greatly resembles the preliminary training for flights on aircraft. The same planning table, the same trainers and playing at submersion, the same checklist for readiness of the equipment and the support means.

"The many years of aviation experience, including weightlessness flights in the laboratory aircraft," said the training director, "will be used completely, of course, considering our wet situation. Safety, just as in flight, has primary significance.... Essentially, the pilots and other procedural experts and I will be solving one problem. Work in space requires much physical effort, vestibular stability and well-developed coordination."

I remembered about coordination when I began to float to the station. At first I was totally unable to orient myself: the transparent hemisphere of the sealed helmet distorts distance in the water. It was necessary to somehow adjust to a new dimension.

I look around. It is a full-scale mockup of the complex. In the blueness of the tank, the Salyut-Soyuz complex appears even more imposing. I involuntarily imagine this powerful structure in orbit and with a sense of participation in space flight I swim into the transfer compartment to open the hatch door. After docking this hatch will be used for the new crew to enter the orbital complex, which, by the way, was excellently demonstrated by Vladimir Dzhanibekov and Oleg Makarov after creating the first manned scientific research complex in the history of astronautics, the Salyut-6, Soyuz-26, Soyuz-27.

The leader swims after. The decrease in pressure and a number of other operations which the astronauts performed on board the Salyut-6, the intentionally omitted: for me the worktime in the water environment was extremely limited by the flight medical commission. According to the work schedule, I prepared to exit from the transfer compartment to "open water space." To do this, I lay down on the floor with my face toward the hatch. I fix the position of my body with my left hand and open the lock with my right hand. All of this is easy and simple. I move backward a little, simultaneously trying to lift the hatch door upward. Nothing happened! The second try also was fruitless....

Perspiration covered my forehead. I can hear my heart beat faster. The water-cooling system comes to my assistance. Nevertheless, the doctor and the training director recommend a rest over the intercom.

The crew leader is still silent. Probably they are laughing among themselves over the inexperienced experimenter. This guess gives me strength. I again try to open the "door to the universe." Alas!

"Let's try to stand up," proposes the crew leader. "Take a hold of the bracket on the right ... be careful not to butt against the cone on the cover!"

"I still don't butt," I answered, slowly assuming a vertical position.

Before submerging they told me that the primary error of those beginning training in the diving suits is colliding with surrounding objects. "For this not to happen," the procedural instructors advised, "it is necessary to move very, very evenly. The speed of a tortoise is the best help when working in the water tank. Indeed, even in space it is necessary to work slowly and carefully."

Finally, the cover is open and fixed in the extreme position. It is true that this has not been accomplished without the assistance of one of the "dolphins...." He showed how to use the lock attachment. I turn over on my chest, I fasten the snap hook of the safety line to the handrail on the inside wall of the compartment.

"I am ready to exit !"

"Don't hurry," the training leader damps my ardor. "Have you calmed down? Now go...."

I run my left hand outside, I turn loose of the bracket with the right hand and smoothly swim out. I can clearly see all parts of the docking unit. The crew leader helps fix my legs so that I will not accidentally float off.

"Report on your seals," they request from on shore.

"Just like they came from the shop," I answer in the words of the report of Georgiy Grechko from space and request permission to check certain parts using a special tool.

"After a little rest."

After a couple of minutes I bring my right hand outside also. I turn so that a little space is left between the outline of the hatch and the cuirass. The leader has handed me the monitoring and adjusting attachment for checking the electric plugs through this opening. Returning to the initial position, I place the tool on the guides. Its base tightly fits in place. Everything is ready!

"Prepare to inspect the rest of the assembly parts."

It would not appear that this is such a complicated operation, but here in the water environment, with zero buoyancy it requires extreme stress on the part of me and the leader. In any case, I am genuinely tired. I have to ask for rest.

"OK," says the director, "you have permission not to perform the tool check."

"We shall proceed according to plan...."

After resting, I inspect each plug of the docking unit. The monitoring and adjusting tool is no longer needed. It can be dropped. The safety strap will not let it float far. However, I pass it to the crew leader hand-to-hand, ever so carefully....

Better spirits are not needed. The heat-regulating system is operating properly. I hear the crew leader ask how I feel from on shore.

"Excellent! I can do some more work," I answer. "Permission requested to exit through the side hatch."

The answer is silence. What is taking them so long? Everything was stipulated before submerging. Apparently they are having a conference. Or have they provided more rest time? On the right I see the smiling face of the crew leader. Now he is standing beside me, almost touching the helmet of my diving suit.

"Permission granted for exit." Approval can be heard in the voice of the crew leader. He knows well with what satisfaction the crews have performed such experiments in training. The exit of the astronauts from the orbital station through the side hatch significantly expands its scientific productivity. With it comes the possibility of changing holders, scientific instruments installed on the surface of the station and performing adjustment operations.

The exit through the side hatch by comparison with the hatch in the docking unit is more convenient. Of course, with the speed of a turtle. However, it also requires significant effort, well-known skill. Especially when fastening the legs outside the station. When this has been done successfully, relative freedom is achieved--the legs of the suit are rigidly connected to the model. Now it is not necessary to hold on by hand all the time. The crew leader is alongside in the hatch opening. He is ready to take the removed equipment and give me other equipment. "It is easier to work everywhere when there are reliable hands of another alongside," said A. A. Leonov, the first to experience the breathing of the universe.

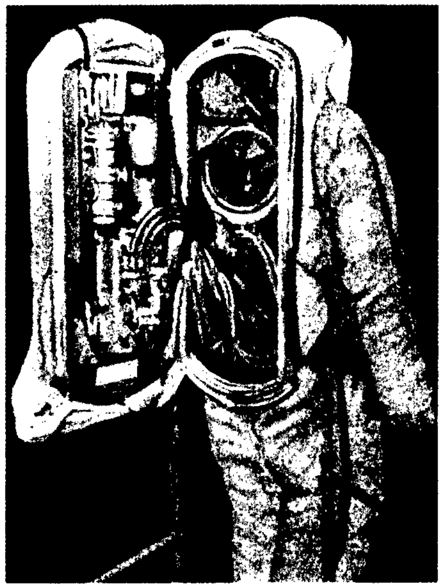
"The second can start," says the training director.

To tell the truth, I set to work with apprehension. When I first saw the sealed gloves, I thought that it would be possible only to hold an ax or a

wrecking bar in them. What complete confusion! On taking the first instrument it seemed like I was feeling it in direct contact with my fingers.

The work of replacing the removable equipment was completed without incident.

"Now you will be an underwater television operator," proposes the leader. "First, pass the second color camera. Let some of the station elements be shown."



New space suit which the crew of the long-term Salyut-6 orbital scientific station used to exit into open space. In the photograph we see a view of the new space suit from the back. On the cover of the entrance hatch an autonomous life-support system is visible. This original design permits the astronaut to climb into the space suit easily without outside help. He spends much less time on this than before. Photograph by A. Zhivayev.

Time for me, it would seem, has stopped. My breathing long ago became normal, and I do not feel the fast heart beat. Out of the corner of my eye in the inspection window of the tank I see the rapt face of the training director.

"May I take a picture for a keepsake?" I say to him, turning the lens in the direction of the underwater port.

"Your time is up," the doctor's voice is heard. "Return to the station, prepare for ascent...."

Of course, it is a shame to leave the water space, but a command is a command. At the exit from the mockup the "dolphins" patiently wait for us--safety first.

Again the winch is locked onto the space suit and it is pulled upward. When on the "dry land" the space suits are doused with clean water from a hose, fatigue again pours over the entire body and it is necessary to make several attempts to get out of the cuirass.

Something surprising occurred also during the medical examination: during the 50 minutes in the water tank, I lost almost 2 kg of weight.

"Your arterial pressure dropped," said the doctor. "By 20 mm of mercury from the upper and lower limits. This is what it meant to be free ... and this in training by the short program. And the astronauts, before being launched into orbit, must spend many hours in the water tank. In that way, later on in their orbital station they feel like fish in water."

10845
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EARTH-TO-ORBITAL STATION RADIO BRIDGE

Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 6, 1978 pp 38-39

[Article by B. Pokrovskiy, engineer of the measurement command complex, honored radio operator]

[Text] Main hall of the flight control center. On an enormous map of the world a bright spot moves on a real time scale. It crosses Africa, and approaches the territory of our country. This means the Salyut-6 orbital scientific station soon will enter the zone of radiovisibility of the Soviet ground tracking stations.

The number of the next orbit, the current time and the orbital parameters will light on the display.

The great television screen is still empty. However, after several minutes the image of the station will appear on it. We see the crew working on board and hear its report.

The specialists with respect to the numerous systems of the station are preparing for the next communications session in their work areas. There is a monitor in front of each of them. By flipping a switch it is possible to "call" information to the screen on the condition of the monitored systems. All of the conversations over the earth-onboard line can be heard in the headsets.

The communications between the control center and the orbital station are not maintained directly: there is an enormous technical system between them made up of the ground and mobile tracking stations. A schematic diagram of it is presented.

For communications with the Salyut-6 station outside the zone of radiovisibility with the territory of the USSR, the flagship of the star fleet of the USSR Academy of Sciences, the "Kosmonavt Yuriy Gagarin" and the new ship "Kosmonavt Vladislav Volkov" which recently was put into operation, are in the Atlantic Ocean, and the fleet veteran "Kosmonavt Vladimir Komarov" is in the Mediterranean Sea. These ships must often carry out

their missions under complex meteorological conditions--during storms and even hurricanes as occurred on 20 December 1977 when the open space walk of astronauts Yu. Romanenko and G. Grechko was being prepared for. The ocean disaster was not calculated with the requirements of the space program. The storm became a hurricane, the wind reached 40 meters per second. The crew of the flagship under the direction of Captain V. Bespalov bravely fought the hurricane. The scientists, engineers and their leader V. Nikiforov, who participated for 50 years in the expeditions on the scientific research ships of the USSR Academy of Sciences, exhibited their endurance. They knew how under the most complicated conditions to extract everything from the equipment that it was capable of and fully support the flight program.

The coworkers of the ground measurement stations in the various climatic zones of the country, frequently in locations that are difficult of access, also have their difficulties.

The scientists create a ballistic flight plan for them in good time before launching the spacecraft and the orbital station. Using the computer, the launch time for the carriers, the time of separation of the spacecraft from them, the docking time and undocking time in flight, the time of including the braking engine for coming out of orbit are calculated by computer. The paths of their movement in space, their orbits, are also determined. Here it is necessary to consider a set of factors. However, no matter how scrupulous the preliminary calculations, the spacecraft move in orbits that are close to the calculated orbits. Therefore the performance of orbital measurements to predict the parameters of motion of the spacecraft is the primary problem and one of the most important problems of the measurement command complex.

For its solution at the ground stations and on certain ships there are trajectory measurement systems which include radar, computers and means of coupling them to the communication channels. The trajectory measurements begin, as a rule, immediately after insertion of the spacecraft into orbit. On receiving the results, the ballistic group of the ground measurement station calculates the ephemerises on the computer, that is, the parameters of motion of the spacecraft during its next passage in the zone of radiovisibility of the given measuring station.

For exact determination and prediction of the orbits which means also for correction of them, the data obtained at one point on the earth are insufficient. Therefore several stations somewhat removed from each other are used. The orbital information comes from them over the communications channels or through the Molniya satellite to the flight control center where the ballistic group on the high-speed computer determine the exact orbit, superposes it on the calculated orbit, and depending on the results of the comparison, makes the decision regarding the expediency of correcting it, correspondence (or lack of correspondence) of it to the docking conditions.

The orbital measurements are the basis for the ballistic flight support of each spacecraft. In order to transmit the instructions of the ballistics experts and the control commands to the servomechanisms, devices, and life-support systems of the spacecraft, for entering the next programs in their onboard automation, transmission of settings, that is, the values changing the previously entered programs, at the ground measurement stations and tracking stations there are command and program command radio channels. As a rule, they are combined into united equipment systems with orbital and telemetric means. The command radio channels themselves include the following: on the ground, the command formation equipment, the amount of which in various combinations can reach several hundred, the transmitting equipment with antennas and receivers for receiving confirmations of the transmission of the commands on board from the spacecraft; and on the spacecraft there is transceiving and recording equipment and a distribution unit which transmits the commands received from the ground to the corresponding onboard servomechanisms.

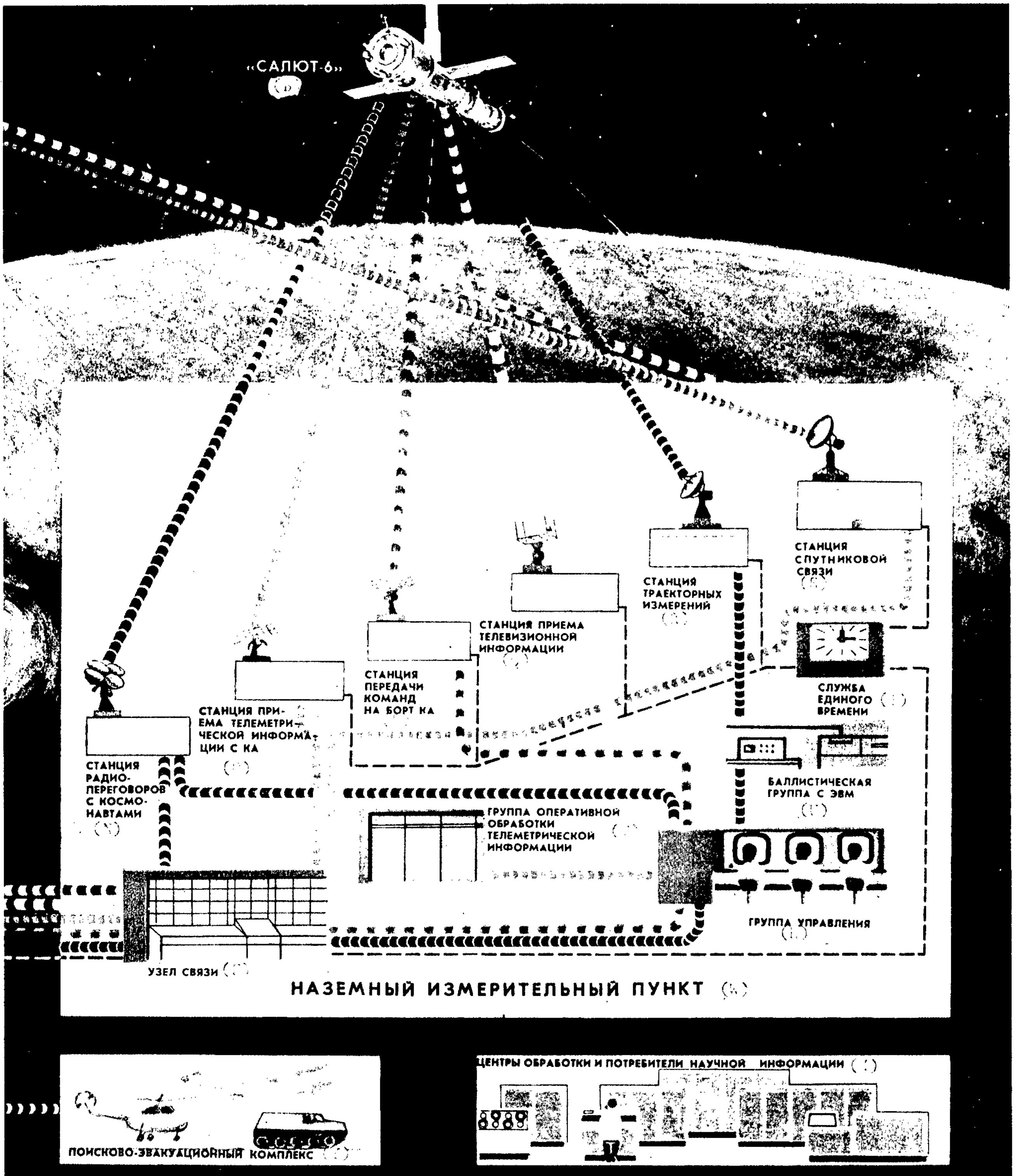
However, then comes the question as to whether command radio channels are needed for manned spacecraft when there is a crew on board? They are used to relieve man of the work which can be successfully performed by automatic machines. This is why the control of the onboard systems of all of the spacecraft by the program command methods and means is necessary and prospective.

Before one command or another is transmitted on board the spacecraft or the station, it must be solidly confirmed that the corresponding systems and instruments, the executors of these commands, are in good working order and that everything is normal on board.

Reliable information about this reaches the ground measurement stations and ships over the set of channels and they constitute the telemetric data.

On the onboard instruments, the operation or the readings of which must be controlled, sensitive converters or sensors are installed. An electric voltage occurs at their output which is proportional to the measured paramaters. It is converted by means of frequency modulation (phase, pulse or amplitude) to an intermediate signal, and in the output modulator, to a radio signal. Thus, the instrument readings which measure the parameters of the vital activity of the living organisms, the air in the work areas, the current in the sources and the cable network, the working medium (fuel) and the functioning of the mechanisms are converted to radio signals.

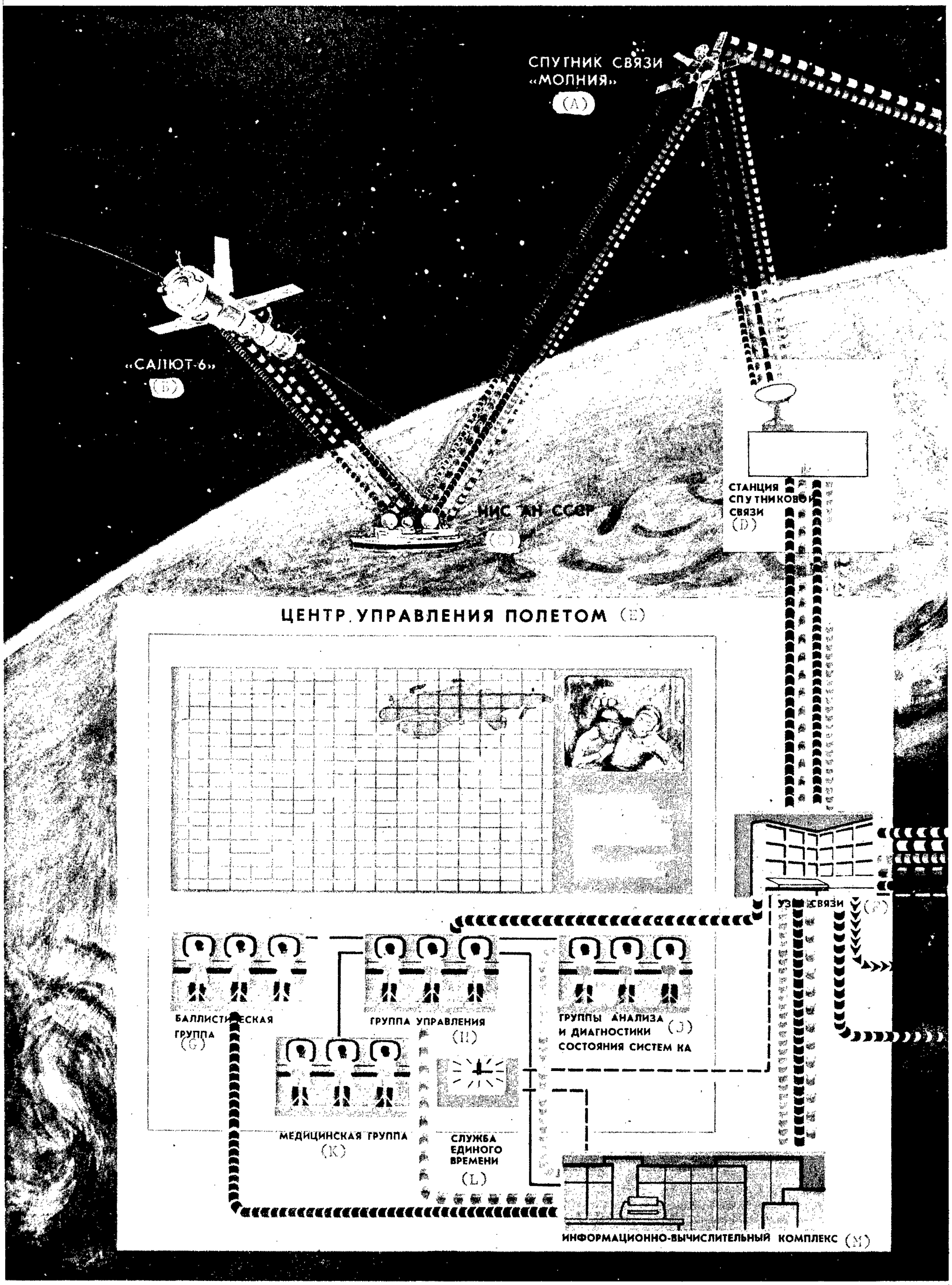
This is the so-called measurement telemetric data. There are signal data which reflect the state of the controlled instrument: "normal," "greater than," "less than," "on," "off."



УПРАВЛЕНИЕ ПОЛЕТОМ ОРБИТАЛЬНОЙ СТАНЦИИ

(ПРИНЦИПИАЛЬНАЯ СХЕМА)

См. статью на стр. 38—39.


СПУТНИК СВЯЗИ «МОЛНИЯ» (A)
«САЛЮТ-6» (B)
НИС АН СССР (C)
СТАНЦИЯ СПУТНИКОВОЙ СВЯЗИ (D)
ЦЕНТР УПРАВЛЕНИЯ ПОЛЕТОМ (E)
УЗЕЛ СВЯЗИ (F)
БАЛЛИСТИЧЕСКАЯ ГРУППА (G)
ГРУППА УПРАВЛЕНИЯ (H)
ГРУППЫ АНАЛИЗА И ДИАГНОСТИКИ СОСТОЯНИЯ СИСТЕМ КА (J)
МЕДИЦИНСКАЯ ГРУППА (K)
СЛУЖБА ЕДИНОГО ВРЕМЕНИ (L)
ИНФОРМАЦИОННО-ВЫЧИСЛИТЕЛЬНЫЙ КОМПЛЕКС (M)

Key to diagram:

A. Molniya communications satellite
B. Salyut-6
C. USSR Academy of Sciences scientific research ship
D. Satellite communications station
E. Flight control center
F. Communications junction
G. Ballistic group
H. Control group
J. Analysis and diagnostic group for the condition of the spacecraft systems
K. Medical group
L. United time service
M. Information computer complex
N. Station for radio conversations with the astronauts
O. Station for receiving telemetric data from the spacecraft
P. Station for transmitting commands on board the spacecraft
Q. Station for receiving television information
R. Trajectory measurement station
S. Satellite communication station
T. United time service
U. Ballistic group with computer
V. Group for operative processing of telemetric data
W. Ground measurement station
X. Processing centers and users of scientific information
Y. Evacuation search complex
Z. Orbital Station Flight Control (schematic diagram)

Depending on the previously developed program the information can be output under way, that is, in the direct transmission regime during flight of the spacecraft over the ground measurement station or stored by the onboard devices and then transmitted to the ground during the next communication sessions. In the required cases the telemetric data can be requested out of turn on command from the flight control center. The information received by the ground station over the continuous electronic conveyor is relayed to the information computer complex of the flight control center where the computer and the automatic processing machines convert the radio signals to physical variables. The most important of them are displayed directly on the display in the main hall. In a number of cases the information is processed directly at the ground measurement stations and then the physical values of only the required parameters are sent to the flight control center on request.

All of the information going to the flight control center is carefully analyzed by the specialists in the spacecraft systems. They also draw the conclusion of the condition and functioning of the instruments and the spacecraft systems, the situation on board. In the case of any deviations the specialists make recommendations regarding the variation of the operating regime of the instruments and the inclusion of the redundant devices.

These recommendations in the form of the corresponding instructions are transmitted to the spacecraft with the help of the command radio lines known to us. Thus, the operatively processed telemetric data are realized. There is also complete processing. It is carried out both during the flight and on completion of it. Its results are used by the scientists and the designers for the concluding evaluation of the operation of the equipment.

All of the measurements, the commands and the control means which were discussed above in general form and in procedural respects are identical for the spacecraft of all types, independently of the purpose. However, the flights of the manned spacecraft and orbital stations are the special concern of the flight control center and the command measurement complex. It is, of course, unnecessary to talk about the significance of the reliability of control and safety of such flights.

The increasing duration and complexity of the work of the people in space require strict agreement and clear interaction of all of the services and specialists of the control center and the command measurement complex, synchronization of their work with the work of the crews of the spaceships and stations, care and comprehensiveness of the monitoring of the condition of the crew, and functioning of the onboard and ground systems.

Here an important role is played by the space vision. On 20 December 1977, G. Grechko stepped out into open space and used a portable color television to transmit space passages.

Television is also of assistance to the controllers. From any ground station it is possible to transmit tables, graphs and text. They are easily read on the screens of the flight control center as a result of the high resolution of the space viewers. The observations of the work and behavior of the astronauts combined with the telemetric information permit more complete representation of how they feel and the state of affairs on board the spacecraft.

The flight of the Salyut-6 orbital scientific station continues. It is reliably supported by the ground navigators--those excellent specialists who have excellently mastered modern techniques and equipment.

10845
CSO: 1870

DIRECTOR OF 'PRIRODA' CENTER STRESSES SIGNIFICANCE OF SPACE PHOTOGRAPHY

Moscow PRAVDA in Russian 24 Jun 78 p 3

[Article by Yu. Kiyenko: "Studying Nature from Space"]

[Text] Space technology is opening up a new stage in natural history and bringing about a technical revolution in the study of natural resources and the environment.

Long-distance methods of exploration from space are based on the fact that all natural formations reflect, absorb and radiate electromagnetic waves of specific frequencies and amplitudes. These radiations may be registered by suitable receivers positioned aboard a space vehicle.

The trends toward developing the study of nature from space are such that, to achieve the maximum future technical and economic output, ever more complex multipurpose probe systems must be installed and comprehensive use made of the space information obtained from the different electromagnetic radiation spectra.

A broad program of photography, instrument and visual observations in the interests of science and the solution of applied natural history problems has already been successfully executed by three crews of the orbital space lab Salyut-6. At present, a fourth crew, V. Kovalenok and A. Ivanchenkov, has embarked on research. A photographic equipment system has been installed in the space lab for obtaining pictures of the Earth's surface in the visible and the near infrared bands. An MKF-6M camera developed jointly by USSR and GDR specialists and equipped with special photographic supplies manufactured domestically makes it possible to produce a simultaneous exposure in six bands of the spectrum. The photographs taken by this camera are a distinct help in studying various natural formations.

A high-precision, wide-format topographical device KATE-140 developed and manufactured by scientists and specialists of the Main Administration for Geodesy and Cartography of the USSR Council of Ministers was also installed in Salyut-6. The ground surface zone of these "earth measurement" devices is 450 kilometers. One photographic exposure covers 200,000 square kilometers.

Such a photograph might simultaneously record several very large regions or areas and practically every water area of such seas as the Azov or Aral'. The information obtained using KATE-140 makes possible the accurate determination of the coordinates of any point on the Earth's surface from great distances, the mapping of vast territories, the study of the relief of a terrain and of the geological structures of very large regions, the monitoring of soil erosion, the condition of pasture land and forests and so on.

It is too early to speak of the final results of using in the national economy information on natural resources already obtained from Salyut-6. The technological cycle for its interindustrial and industrial processing is complex and of long duration. However, it is clear that the data about our planet which has been transmitted from orbit is of great scientific and practical interest. For instance, it has become possible to identify and map ocean currents, to detect oil pollution in areas of the ocean, to obtain data on the relief of shoal water areas and on the discharge of industrial waste into the atmosphere and more.

Photographic data from Salyut-6 is sent to more than 400 of the country's organizations and is available to thousands of scientists, engineers and specialists. The results of visual surveys are just as valuable. Cosmonauts working in orbit have passed through special training in the area of nature study from space. A crew, which only takes on the duty aboard a space lab, goes through this kind of preparation and training in high-altitude airplanes.

Photographs of the Earth taken previously from other space vehicles (such as Salyut-4) are already being used in various sectors of the national economy and have yielded a wealth of information about the country's natural resources. Thus, a pool of fresh water was discovered under sand dunes in the deserts of the Kizil-Kum using space photographs; oil and gas bearing structures have been detected and information has been obtained about the underwater topography of the shoal area of a shelf which has made it possible, among other things, to identify prospective oil exploration sites in the northeastern areas of the Caspian Sea.

In one of the old petroleum extraction regions, 102 promising structures were located in 60 years using traditional methods. After five months of studying space photographs of this territory, 84 new sites have been successfully identified where exploration would be expedient.

The examples given demonstrate that space photography yields an enormous gain. The results of orbital exploration are being used in planning and surveying operations for laying out large-scale linear constructions such as the oil and gas pipelines for Western Siberia and the European section of the country, for designing ten hydroelectric power stations in the Caucasus, Tien-Shan, Pamir and other regions, for seismic zoning in civil and industrial construction in the Southern and Southeastern USSR. Space data is available to scientists and designers studying the problems of diverting parts of the flow of Northern rivers to Southern regions.

The interest of different sectors of the national economy in information from space is increasing continually. In the past two years the number of organizations using data from long-distance probes has doubled while the amount of data delivered to them has increased by a factor of six. It is safe to predict a continued growth in both the number of users and the amount of information used. And this is not accidental.

Satellite photographs permit implementation of the most effective principle for studying natural resources and the environment. Traditional methods are based on gathering and correlating unrelated and diverse individual observations which are often corried out using incommensurable methods. Now, with extremely large distances being survayed from space practically at a single time and information being obtained simultaneously from many parts of the electromagnetic radiation spectrum, it is possible to make a better decision on a strategy for mineral prospecting.

Space nature study equipment provides the greatest technical and economic impact in the detailed study of territories. One and the same photograph is of interest to geographers, petroleum specialists, cartographers, land developers, soil scientists, land managers and specialists in forest and agricultural economy. The comparison of photographs taken at different times yields information on the dynamics of change in the environment.

Using the results of orbital photographs, it is possible to detect as yet hidden natural resources. For this reason, there should be a state-wide inventory of the natural resources based on space information and at the same time an identification of the stock of resources not yet explored. Technical and economic evaluation of the expediency of setting up such an operation in one of the mountainous regions of a nearly one million square kilometer area has demonstrated that a cost outlay of about six million rubles could result in savings many times greater.

"Main Directions for the Development of the USSR National Economy from 1976-1980" calls for the creation of new and the development of existing territorial manufacturing complexes. An inventory of natural resources in these particular regions using space data promises a very large yield since detailed knowledge of the potential of the regions makes it possible to select the optimum alternatives for their development.

As with any promising direction in science and technology, the study of nature from space has great future and numerous unsolved problems. With the creation of high-output, wide-range, onboard Earth survey equipment should be grouped the construction of high speed automatic systems for processing the space information. It would be unthinkable to "digest" by traditional methods the extremely large volume of information on natural resources and the en-environment which space techniques have made it possible to supply or to convey it to users without using high speed computers and optico-electronic systems. A photograph of a territory can be produced in four to five minutes of the flight of Salyut-6 whereas it might take one and one-half to two years to accomplish the same thing from an airplane. Because of this, the resources

for processing the information must be increased and a strong industrial base placed at the service of space nature study.

We have shown that, as the work of the crews aboard the orbiting space lab Salyut-6 is contributing to the continued development of astronautics, one of its promising and challenging directions is the study of nature from space. The resolutions of the 25th CPSU Congress which point out ways to apply space techniques in the interests of our nation are being successfully brought to life.

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ALL-UNION SCIENTIFIC-PRACTICAL CONFERENCE CONTINUES

Alma-Ata TRUD in Russian 7 Jun 78 p 3

[Text] Yesterday the All-Union Scientific-Practical Conference "ASU-Aided Information Reference Service of Social Organizations" ("ASU--Zavkom") opened at the Higher School of Trade Unionism (VShPD) of the All-Union Central Trade Union Council (VTsSPS). It was organized by the All-Union Council of Scientific and Technical Societies (VSNTO), the State Committee of the Council of Ministers of the USSR for Science and Technology (GKNT), the Scientific Council on Problems of Socialist Competition of the Academy of Sciences USSR; and the Higher School of Trade Unionism imeni N. M. Shvernik. Department and ministry leaders as well as party, soviet, trade union and komsomol workers, scientists and representatives of the plant local committee enterprises are taking part in the conference.

The conference was opened by Rector of the VShPD Professor G. V. Sharapov. Reporting were First Deputy Director of the VSNTO N. N. Gritsenko; Deputy of the Secretary of the Party Committee of Moscow Machine-Tool Building Plant "The Red Proletariat" N. M. Tikhonov; Deputy Director of the Main Administration of Computer Equipment and Control Systems of the GKNT N. I. Cheshenko, pro-rector of the VShPD Professor K. P. Stayev, Director of the VTsSPS computer center V. I. Tseplyayev, principal editor of the magazine "Socialist Competition" Professor V. G. Smol'kov and others.

Also present were representative of the VTsSPS A. I. Shibayev, Secretary of the VTsSPS I. M. Vladychenko, representative of the VSNTO Academician A. Yu. Ishlinskiy, representative of VAK (High Degree Commission?) under the Council of Ministers Professor V. G. Kirillov-Ugryumov.

The conference continues today.

CSO: 1870

SCIENTISTS AND SCIENTIFIC ORGANIZATIONS

FAR EASTERN SCIENTIFIC CENTER ACTIVITIES DESCRIBED

Moscow NEDELYA in Russian No 23(951), 5-11 Jun 78, pp 4-5

[Article by G. Klimov, special correspondent for NEDELYA, based on a round-table discussion with members of the center]

[Text] The "Far East" Program

Nikolay Shilo, Chairman of the Presidium of the Far Eastern Science Center, Academician, Hero of Socialist Labor.

The institutes and subunits of the Far Eastern Science Center (DVNTs) of the USSR Academy of Sciences began the development of a long-term program of research, "Far East," which emcompasses both the problems of basic science and the development of practical principles for the strengthening of the industrial bases of the region. Special attention is being given to the active and rational opening up of the material resources of the kray based on those changes in the economy of Siberia and the Far East which were dictated by the decision of the 25th CPSU Congress. A number of sections are closely tied to the most important economic objectives such as the construction of the Baykal-Amur Mainline and the creation of new territorial production complexes.

The development of scientifically-based constructive measures to raise the effectiveness of the entire rayon's economy is an important part of this program. We received new stimulus in this work thanks to the recommendations and directions of Comrade L. I. Brezhnev concerning the most important problems of comprehensive assimilation of natural resources and the development of productive forces in Siberia and the Far East.

The subunits of DVNTs often solved problems which were not completely responsive to the role of the Far East which it [DVNTs] is called upon to play in the country's economy, and which is dictated by its geographical location. Therefore, our mission in the first stage of development of the "Far East" program is to prepare the scientific basis for comprehensive evaluation of perspectives for developing the kray.

The shortening of the "research-production" cycle remains a serious task. There are well defined achievements in this plan. If, for instance, during the last five-year plan when DVTs was building up, 19 developments were put into production, last year more than 80 completed research projects were put into production by the various branches of industry and agriculture.

All of these measures together, and also state and party interest on the part of scientists in the results of their labors, will enable far eastern science, in the next few years, to increase its potential and make an appreciable contribution to the economy of the entire country.

Andrey Krushanov, Deputy Chairman of the Presidium of the Far Eastern Science Center, Member-correspondent of the USSR Academy of Sciences.

I have the pleasant and challenging task to inform the readers of NEDELYA about our scientific center. Founded in 1969 in Vladivostok, it formed a large comprehensive union of academic institutions including 16 institutes, nature bases and preserves throughout the entire Far East and its own expeditionary navy. Research is conducted in a huge territory from the northern tundra to the sub-antarctic waters; processes in the depths of the earth, the sea and on the sun are studied.

Many of our institutes work not only on the basic research, but also on concrete economic problems. The Institute of Sea Biology maintains practical and fruitful contact with fishermen, and the Northeast Complex of NII's [Scientific Research Institutes] with geologists. But I think the participants themselves, in today's meeting, should discuss their work and the problems which are being solved by their collectives.

Our center is located on the shore of the Pacific Ocean. It is natural that many scientific investigations are tied to it. The first word from behind our roundtable goes to the researchers.

Neptune's Pharmacy

Georgiy Elyakov, Director of the Pacific Ocean Institute of Bioorganic Chemistry, Member-correspondent of the USSR Academy of Sciences.

The fact that four-fifths of all living organisms, more than 160,000 forms, live in the ocean will apparently surprise people who spend their entire lives on dry land.

Our institute studies the chemistry and biochemistry of sea animals and vegetation. In this work, we study biologically active substances separated from sea organisms, which can find application in the creation of biochemical preparations and medicines.

An acceleration in the development of research in such basic problems of health as cardiovascular, psychiatric and viral illnesses is envisioned by the decisions of the 25th CPSU Congress. It is possible that the study of sea organisms will help scientists and doctors defeat serious illnesses. We have obtained notable results during the past years--substances having physiological activity, particularly against malignant regeneration, have been separated. A tremendous variety of all possible forms of life, and consequently biological processes, are concentrated in the ocean. Take even sea sponges. Substances are taken from them that have extremely powerful antimicrobial properties and are devoid of defects which are inherent in "land" antibiotics. Even representatives of the echinoderms--sea cucumbers, sea urchins, starfish--are studied at our institute. They contain substances of so-called polycyclic structure which can become a source of steriod hormones and have antimicrobic properties.

"SKAT" Goes to the Bottom

Viktor Perchuk, Deputy Director of Automation and Management Processes, Doctor of Technical Sciences.

Since we have already talked about ocean research, I will discuss an apparatus which was created here in the institute by a group under the

leadership of Doctor of Technical Sciences M. D. Ageyev. This "SKAT" is an unmanned underwater apparatus for investigating the shelf zone. It has been successfully tested and the reliability of the system has been proved. Before submerging it receives a fixed program and then carried it out by itself. It submerges to the specified depth and moves in the proper direction. The navigation system continuously determines "SKAT's" location and sends its coordinates to the accompanying ship.

The apparatus is multipurpose. All instruments are installed in the capsule. Data from them are written down on magnetic tape. We are now working to send the information immediately to the shipboard. "SKAT" informs sea biologists about the vegetation and animal world. and geologists about the structure of the ocean floor. During testing engineers installed camcameras and videotape recorders onboard. The first photos and films were very valuable.

We are working in another direction--important in order to raise the effectiveness of the scientists' work--automated research. We are putting in computers of various types with large memories. The aim is to help scientists perform calculations and bring them nearer to computer technology so they can carry on a dialog in a language which both the scientist and the machine can understand. For this goal we are establishing a regional computer net "OKEAN" in the DVNTs. The first phase of it is already operational. A Krushanov: "It should be added that institute automation and management processes, which are installed by highly qualified cadres of programmers and mathematicians, are rendering considerable help to the computer centers of Maritime Province enterprises.

Floating Institutes

Grigoriy Prosh'yants, Scientific Secretary of the Oceanographic Commission, Candidate of Geographical Sciences, Captain of Long-range Voyages

It is impossible to study the Pacific Ocean without a scientific navy. There is a distinctive morrage in Zolotoy Rog Bay in Vladivostok from which the scientific research ships of DVNTs sail on voyages--our family of floating institutes.

We recently again sailed the "Kallisto" to the tropics with scientists who will study coral reefs on board.

We are now planning a voyage for the "Bulkanologa"; it will "listen" to the extinct volcano Il'-de-Tsendr and study the evolution of volcanism in examples of the Hawaiian Imperial Chain.

The navy is continuously enlarging. A new ship, the "Professor Bogorov," which specializes in hydrophysics and geophysics research, was put at the moorage in the spring. The flat on the "Berill" will soon be raised.

Secrets of the Deep

Viktor Il'ichev, Director of the Pacific Ocean Oceanological Institute, Member-correspondent of the USSR Academy of Sciences.

Oceanology specialists are trying to answer questions which are disturbing to mankind. Take even one of them--long-term prognosis of the weather. Well the ocean, in a manner of speech, is a huge heater. Large surpluses of heat are accumulated in the tropics and are carried by streams to the northern latitudes where they meet cold waters. The moist masses migrate and heat escapes into the atmosphere. This is the scheme. As a matter of fact, everything is much more complicated. Recall how streams are pictured on geographical maps. These powerful currents are like rivers in the ocean. In actuality they are very unstable. Eight years ago scientists discovered large-scale whirlpools in the ocean which are analogous to cyclones and anti-cyclones in the atmosphere. They very significantly influence the entire dynamics of the ocean and the transfer of heat to the atmosphere upon which the weather depends. The explanation of these phenomena requires great and simultaneous effort from many scientific organizations. What is needed, for instance, is a synchronized picture of the ocean and the atmosphere in large areas. Therefore, scientists from our institute and the Siberian Division of the USSR, Academy of Science together with American scientists are cooperating in this field through the WESTPAC program.

The ocean is a complicated structure. It is also the discovery of our century, made possible by the use of sensitive instruments. And one of the missions of our institute is to develop new physical methods of research. In the laboratory under the leadership of V. P. Shevtsov, original instruments to detect effects connected with the delicate structure of the ocean have been created. We are developing methods using the laser. One of the institute's programs is dedicated to the study of the transmission of contaminating substances and the detection of the self-cleaning capabilities of the ocean. A group of scientists are performing serious work which will

permit prediction of the movement of oil spots and the speed of disintegration under various weather conditions and work out recommendations for the struggle with contamination.

On the modern level, by making use of electronic technology, geological and geophysical research is being conducted with the aim of creating the bases of predicting, for instance, the distribution of useful mineral resources in the ocean.

The Green Sea of the Taiga

Vsevolod Rozenberg, Chief of the Forest Branch of the Billogical-Soil Institute, Candidate of Biological Sciences

The Taiga occupies approximately 250 million hectares. In the north grow mainly larch, and further south spruce, cedar and ash. Rare species are also seen such as the Amur Phellodendron, Iron Birch, Manchurian Nut and dimorphant. But the most valuable are the unique cedars which give excellent wood and rich harvests of nuts consisting of 60 percent edible meat. In the fall 300-400 cones each of which weighs 200-300 grams can be gathered from one tree. It is not by accident that the cedar is called the far eastern "bread tree."

Our department is now developing a study of the types of forests in the Far East. By 1980 on the basis of these scientific data we must propose a system which will promote their rational use.

Expeditionary teams are leaving for the sparse northern forest, the taiga on the eastern leg of BAM, and for the inpenetrable mixed vine forest south of the Maritime Provinces. It is necessary, for instance, to reveal the diversity of spruce forests in Sakhalin and the Maritime Provinces and to give recommendations for their best use to the economy. Research of many years is also being conducted at bases located in different parts of Sikhote-alin'.

I must say that there are still not enough scientists studying forest problems in the Far East. We invite the foresters of the universities of Leningrad, Moscow, and Kazan and the Estonian Academy of Sciences. Similar collaboration has allowed us to conduct research on amh important problems in the past few years.

The results are being put into practice more than ever. The "specifications governing the chopping for primary use in the Far East" are now in preparation; they have been developed by coworkers in the Forest Branch of our institute and Dal'HIILKh [Far Eastern Scientific Research Institute of Forest Economy].

Workers in our department have recently developed forestry management measures for the fir-spruce forests of the Maritime Provinces. If they are applied at the very beginning of tree growth, then the period of maturity is reduced 30-40 years. This is a significant achievement, for a fir or spruce tree takes 120-140 years to mature to the point where it can be cut. And now they become "adults" in 80-10 years.

Foresters help the taiga not only to restore itself and grow faster, but they stand before the onslaught of industry. The far eastern economic region is living through an era of stormy development. They are building powerful enterprises in the silent taiga and it is important for us to know what types of vegetation can exist in the zones of intense industrial construction. Not so very far from the mining town of Dal'chegorsk, laboratory workers at a scientific base, under the leadership of Doctor of Biological Sciences B. I. Tarankov, are studying at this time the effects of industrial waste on the surrounding nature.

The Earth is Young and Ancient

Yuriy Badenkov, Deputy Director
of the Pacific Ocean Institute
of Geography, Candidate of
Geological and Mineralogical
Sciences.

Really, nature is very volnerable. Everything is interrelated. Therefore there is no way that you can look upon, say the northern and southern land masses as single entities. Some are interrelated and others are resistant to various actions of the elements and the economic activity of man. We were once again convinced of this truth during an expedition to the southwest part of the Pacific Ocean where they are studying the ecological systems of the tropical islands under an international program "Man and the Biosphere." Mature land masses, which for tens of thousands of years have not been subjected to catastrophic phenomena, forced us to look at nature through other eyes.

We, people of the northern climes, became used to evaluating our surroundings as our own pool of resources. Even though that is not so. As a result of glaciation the soil cover was washed away and our territory became

younger than the tropics. The comparison and study of various eco-systems after the expedition allowed us to make some conclusions of practical significance.

In the Far East there are land masses of various ages and interrelationships. It is known that in the tundra even cross-country vehicles are destroying the soil, and in the south similar processes are less noticeable. Such a characteristic, depending on the zones, whould be taken into account during the exploitation of territories and projected in the plans of the logging and mining industries.

One can make recommendations for the rational use of natural resources by analyzing and comparing observations according to time. Recently, laboratory workers, led by Doctor of Geophysical Sciences Yu. G. Puzachenko, analyzed, with the aid of mathematical methods, changes in the microclimate in the south of the Far East during the last 150 years. They determined that now we are observing a temporary periodic tendency toward a reduction of rains. The economy must be prepared for this.

Our region is developing quickly. According to predictions, the population will double by the year 2000. It connection with that I would like to mention the research of a young scientist, Petr Baklanov, which was dedicated to the geography of positioning industrial objects in the area of BAM and the Far East. His work earned a gold medal from the USSR Academy of Sciences.

A. Krushanov: "Our scientists have acquainted you with only some of the things they are working on. The far-eastern scientists still have a lot of work to raise the effectiveness of scientific searches and bring them closer to today's problems. In this matter, the directions and recommendations of comrade L. I. Brezhnev, made in his speeches during his trip through Siberia and the Far East, have been especially valuable to us.

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M. V. KELDYSH INTERRED IN KREMLIN WALL

Moscow IZVESTIYA in Russian 30 Jun 78 p 2

[Article: "The Last Journey"]

[Text] On 29 June the funeral of outstanding modern-day scientist, member of the CPSU Central Committee, and deputy to the USSR Supreme Soviet, Academician Mstislav Vsevolodovich Keldysh, was held in Moscow.

This was the second day that the conference hall of the Presidium of the USSR Academy of Sciences bore signs of mourning. An urn containing M. V. Keldysh's ashes was set up on a tall pedestal. Walking past it, as they had on the day before, were Muscovites in an unending stream. They had come to give tribute of profound respect to a faithful son of the Leninist party and a prominent organizer of science.

More and more wreaths were brought into the hall -- wreaths from representatives of scientific and production collectives, and party, soviet, and public organizations.

Eleven hundred hours. Access to the deceased's ashes is discontinued. Mournful melodies are played. Members of the commission for organizing the funeral remove the urn with M. V. Keldysh's ashes from the pedestal and place it on a catafalque. The process sets out for downtown Moscow. At the House of Unions, the urn is transferred to a gun carriage. Accompanied by a military escort, the funeral procession moves out to Red Square, where thousands of representatives of workers in the capital have gathered.

The funeral cortege arrives at Red Square. The urn with M. V. Keldysh's ashes is placed on a pedestal.

Up onto the platform go Comrades L. I. Brezhnev, Yu. V. Andropov, V. V. Grishin, A. A. Gromyko, A. P. Kirilenko, F. D. Kulakov, M. A. Suslov, D. F. Ustinov, P. N. Demichev, V. V. Kuznetsov, B. N. Ponomarev, M. S. Solomentsev, K. U. Chernenko, I. V. Kapitonov, V. I. Dolgikh, M. V. Zimyanin, Ya. P. Ryabov, and K. V. Rusakov.

On instructions issued by the CPSU Central Committee, the Presidium of the USSR Supreme Soviet, and the USSR Council of Ministers, the funeral ceremonies are opened by chairman of the governmental commission for organizing the funeral, Deputy Chairman of the USSR Council of Ministers L. V. Smirnov. He emphasized that Mstislav Vsevolodovich's activities were distinguished by a profound devotion to party principles, and by a state approach. He was able to organize the work of many collectives of scientists to resolve important, comprehensive tasks for the national economy, and he was greatly concerned about the reinforcement of the material base of science, since he was profoundly aware that, in the age of intensive scientific-technical progress, it is only the labor of collectives that are armed with highly-improved instruments and apparatus that can assure the successful completion of the task assigned. Mstislav Vsevolodovich was not only an outstanding scientist, but also a wise educator of a vast number of highly qualified specialists. Throughout the more than 40 years of his pedagogical activity, he educated new generations of talented scientists and engineers, who are now working successfully in scientific-research institutes and design bureaus. M. V. Keldysh made an important contribution to the organization and development of international scientific cooperation, primarily with the socialist countries. The purposeful struggle for peace and friendship among peoples, for the scientific cooperation among the scientists of all countries, owes a great deal to him.

The President of the USSR Academy of Sciences A. P. Aleksandrov noted that the most outstanding achievements of Soviet and worldwide science and technology are linked with the name of M. V. Keldysh. Soviet science owes much to him because of the fact that our mathematical and aerohydrodynamic schools occupy forward positions in the world. He was one of the leading scientists and organizers of scientific projects that made it possible to create the nuclear-missile shield for our Motherland. While heading the USSR Academy of Sciences for almost 15 years, he made an outstanding contribution to the development of Soviet science, particularly in such new fields as molecular biology and genetics.

The broad horizon of the Communist scientist, his profound adherence to ideology, his state approach to the solution of the problems that arose, his high sense of principles, and his devotion to the Motherland and the party's cause won M. V. Keldysh universal love.

Mstislav Vsevolodovich struck those he met by his unusually democratic manner, the flexibility of his mind, his desire to understand completely the person to whom he was speaking, his desire to help him whenever he had any scientific or everyday difficulties. He was extremely demanding. His service to science was highly motivated and selfless.

The name of the outstanding Communist scientist who gave all his efforts and capabilities to unselfish service to science and his nation will remain forever in the hearts of Soviet citizens.

The next person to speak was Secretary of the MGK [Moscow City Committee] of the CPSU, V. N. Makeyev. Soviet science, he said, owes much of its unmatched progress and world fame to remarkable people such as Mstislav Vsevolodovich Keldysh. Graduate of Moscow Univery, and talented continuer of the best traditions of Soviet science, he was a model of the scientist of the new, socialist era. He combined within himself the passion of the researcher in fundamental problems with the practical attitudes of an active creator of the new. When he was 35 years old, he was elected academician. Mstislav Vsevolodovich throughout his life faithfully followed the Leninist behest -- to strengthen the union between science and labor. The outstanding scientist bore proudly the name of party member. The Communists of Moscow repeatedly elected him delegate to congresses of the CPSU. As a Communist and scientist, he undeviatingly implemented the party's wise policy that had been developed by the Leninist Central Committee and by its Politburo headed by General Secretary of the CPSU Central Committee, Chairman of the Presidium of the USSR Supreme Soviet Comrade L. I. Brezhnev. Muscovites are deeply indebted to Mstislav Vsevolodovich for the major contribution that he made to the reinforcement of the creative collaboration between science and production, to the development of the ties among the scientific-research institutions and the industrial enterprises in the capital. The academician always participated, with a high sense of self-interest, in the struggle waged by the Muscovites to convert the capital into a model Communist city. His brilliant talent, his ebullient creative energy, his varied knowledge, and his outstanding scientific achievements were completely devoted to the reinforcement of the might of our Motherland, to the cause of the construction of communism.

The death of Mstislav Vsevolodovich Keldysh is a tremendous, irreplaceable loss for the scientists of the countries of the socialist community, Academician A. Balevski, President of the Bulgarian Academy of Sciences, said. The life and the unparalleled exploits of the outstanding scientist will be studied for many, many years. They constitute an example of unselfish service to the brilliant ideals of science, to the ideals of the construction of the socialist and communist society. He will continue to inspire youth to carry out important jobs. The outstanding scientific achievements linked with the name of M. V. Keldysh have influenced, and continue to influence, in the most direct manner, the development of science in the socialist countries. The academician made an incomparable contribution to the organizing of the cooperation among the scientists of the socialist states.

In his statement at the funeral ceremonies, twice Hero of the Soviet Union USSR Cosmonaut-Pilot V. A. Shatalov emphazied that Soviet cosmonauts knew M. V. Keldysh not only as an outstanding modern-day scientist and organizer of science. For Soviet cosmonauts he was also a good friend, who shared with them all the difficulties involved in taking the first steps of mastering space. His wise advice, his kind attention, his fatherly concern gave the cosmonauts inestimable aid in their work. M. V. Keldysh taught them to see the prospects of that important job that they were serving, directing them toward the solution of even more stupendous tasks during

the execution of piloted space flights. Each step taken on the glorious path of Soviet cosmonautics is linked with the name of M. V. Keldysh -- from the launching of the first Soviet artificial earth satellite to the launching of interplanetary stations and complex space systems, from the first historic flight taken by Yuriy Gagarin to the 96-day record flight of Yuriy Romanenko and Georgiy Grechko. The outstanding scientist made a tremendous contribution to the carrying out of flights by the Soyuz and Apollo spacecraft, to the development of the Interkosmos [Interspace] program, which made it possible for a representative of already the second socialist country to take part in work on board an orbital scientific-research Salyut-Soyuz complex. Soviet cosmonauts preserve the memory of him not only in their hearts, but also in their deeds for the good of the socialist Motherland, to the unselfish service to which Academician M. V. Keldysh devoted his entire brilliant life.

The funeral ceremonies are over. The leaders of the Communist Party and the Soviet government lift the urn containing the ashes of M. V. Keldysh and move toward the Kremlin wall. To the accompaniment of three volleys of an artillery salute, the urn is installed in a niche, which is closed by a marble slab.

Engraved on it is the inscription:

Mstislav Vsevolodovich
KELDYSH

10	24
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A funeral march starts to play. It is replaced by the melody of the State Anthem of the Soviet Union. Showing their last respects to M. V. Keldysh, military subdivisions parade solemnly across Red Square.

Moscow, Red Square, 29 June 1978. Leaders of the Communist Party and the Soviet State carrying the urn containing the ashes of M. V. Keldysh. (Photograph by S. Smirnov)

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END